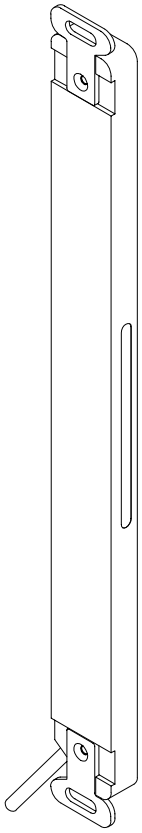
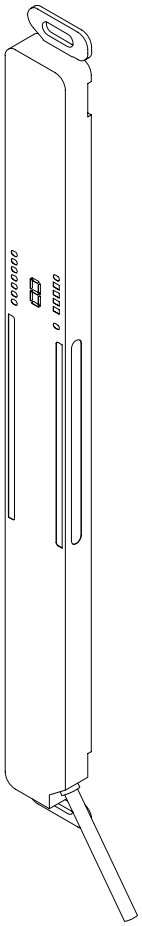
SUNX

INSTRUCTION MANUAL

Light Curtain Ultraslim / Type 4

SF4C Series





(MEMO)

Thank you for purchasing SUNX's Ultraslim Light Curtain, **SF4C** series.
Please read this instruction manual carefully and thoroughly for the correct and optimum use of this device.
Kindly keep this manual in a convenient place for quick reference.

This device is a light curtain for protecting a person from dangerous parts of a machine which can cause injury or accident.

This manual has been written for the following personnel who have undergone suitable training and have knowledge of light curtains, as well as, safety systems and standards.

- who are responsible for the introduction of this device
- who design the system using this device
- who install and connect this device
- who manage and operate a plant using this device

Notes

1) All the contents of this instruction manual are the copyright of the publishers, and may not be reproduced (even extracts) in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from the publisher.
2) The contents of this instruction manual may be changed without prior notice for further improvement of the device.
3) Though we have carefully drawn up the contents of this instruction manual, if there are any aspects that are not clear, or any error that you may notice, please contact our local SUNX office of the nearest distributor.

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Chapter 1 Introduction

1-1 Attention Marks

This instruction manual employs the following attentions marks ⚠WARNING, ⚠CAUTION depending on the degree of the danger to call operator's attention to each particular action. Read the following explanation of these marks thoroughly and observe these notices without fail.

⚠WARNING If you ignore the advice with this mark, death or serious injury could result.

⚠CAUTION If you ignore the advice with this mark, injury or material damage could result.

<Reference> It gives useful information for better use of this device.

1-2 Safety Precautions

- Use this device as per its specifications. Do not modify this device since its functions and capabilities may not be maintained and it may malfunction.
- This device has been developed / produced for industrial use only.
- This device is suitable for indoor use only.
- Use of this device under the following conditions or environment is not presupposed. Please consult us if there is no other choice but to use this device in such an environment.
  1) Operating this device under conditions or environments not described in this manual.
  2) Using this device in the following fields: nuclear power control, railroad, aircraft, automobiles, combustion facilities, medical systems, aerospace development, etc.
- When this device is to be used for enforcing protection of a person from any danger occurring around an operating machine, the user should satisfy the regulations established by national or regional security committees (Occupational Safety and Health Administration: OSHA, the European Standardization Committee, etc.). Contact the relative organization(s) for details.
- In case of installing this device to a particular machine, follow the safety regulations in regard to appropriate usage, mounting (installation), operation and maintenance. The users including the installation operator are responsible for the introduction of this device.
- Make sure not to have a impact on this device like falling. It may cause breakage of this device.
- Use this device by installing suitable protection equipment as a countermeasure for failure, damage, or malfunction of this device.
- Before using this device, check whether the device performs properly with the functions and capabilities as per the design specifications.
- In case of disposal, dispose this device as an industrial waste.

⚠ WARNING

♦ **Machine designer, installer, employer and operator**

- The machine designer, installer, employer and operator are solely responsible to ensure that all applicable legal requirements relating to the installation and the use in any application are satisfied and all instructions for installation and maintenance contained in the instruction manual are followed.
- Whether this device functions as intended to and systems including this device comply with safety regulations depends on the appropriateness of the application, installation, maintenance and operation. The machine designer, installer, employer and operator are solely responsible for these items.

♦ **Engineer**

- The engineer would be a person who is appropriately educated, has widespread knowledge and experience, and can solve various problems which may arise during work, such as a machine designer, or a person in charge of installation or operation etc.

♦ **Operator**

- The operator should read this instruction manual thoroughly, understand its contents, and perform operations following the procedures described in this manual for the correct operation of this device.
- In case this device does not perform properly, the operator should report this to the person in charge and stop the machine operation immediately. The machine must not be operated until correct performance of this device has been confirmed.

♦ **Environment**

- Do not use a mobile phone or a radio phone near this device.
- If there exists a reflective surface in the place where this device is to be installed, make sure to install this device so that reflected light from the reflective surface does not enter into the receiver, or take countermeasures such as painting, masking, roughening, or changing the material of the reflective surface, etc. Failure to do so may cause the device not to detect, resulting in death or serious injury.
- Do not install this device in the following environments.
  1) Areas exposed to intense interference (extraneous) light such as high-frequency fluorescent lamp (inverter type), rapid starter fluorescent lamp, stroboscopic lights or direct sunlight.
  2) Areas with high humidity where condensation is likely to occur
  3) Areas exposed to corrosive or explosive gases
  4) Areas exposed to vibration or shock of levels higher than that specified
  5) Areas exposed to contact with water
  6) Areas exposed to too much steam or dust

♦ **Installation**

- Always keep the correctly calculated safety distance between this device and the dangerous parts of the machine.
- Install extra protection structure around the machine so that the operator must pass through the sensing area of this device to reach the dangerous parts of the machine.
- Install this device such that some part of the operator's body always remains in the sensing area when operator is done with the dangerous parts of the machine.
- Do not install this device at a location where it can be affected by wall reflection.
- If this device is used in multiple sets, arrange them to avoid mutual interference.
  For details, refer to "**2-3-4 Device Placement**."
- Do not use any reflection type or recursive reflection type arrangement.
- The corresponding emitter and receiver must have the same serial No. and be correctly oriented.

⚠ WARNING

♦ **Machine in which this device is installed**

- When this device is used in the "PSDI Mode," an appropriate control circuit must be configured between this device and the machinery. For details, be sure to refer to the standards or regulations applicable in each region or country.
- In Japan, do not use this device as a safety equipment for a press machine.
- Do not install this device with a machine whose operation cannot be stopped immediately in the middle of an operation cycle by an emergency stop equipment.
- This device starts the performance after 2 sec. from the power ON. Have the control system started to function with this timing.

♦ **Wiring**

- Be sure to carry out the wiring in the power supply OFF condition.
- All electrical wiring should conform to the regional electrical regulations and laws. The wiring should be done by engineer(s) having the special electrical knowledge.
- Do not run the wires together with high-voltage lines or power lines or put them in the same raceway. This can cause malfunction due to induction.
- In case of extending the cable of the emitter or the receiver, each can be extended up to 40.5m by using the exclusive cable. Furthermore, if the cable is extended, the muting lamp is used, the total extendable length of the cable. For details, refer to WARNING under "**2-5-3 Wiring / Connecting Procedures and Terminal Arrangement**."
- Do not control the device only at one control output (OSSD 1 / 2).
- In order that the output is not turned ON due to earth fault of the control output (OSSD 1 / 2) wires, be sure to ground to 0V side (PNP output) / +V side (NPN output).

♦ **Maintenance**

- When replacement parts are required, always use only genuine supplied replacement parts. If substitute parts from another manufacturer are used, the device may not come to detect, result in death or serious injury.
- The periodical inspection of this device must be performed by an engineer having the special knowledge.
- After maintenance or adjustment, and before starting operation, test this device following the procedure specified in "**Chapter 4 Maintenance**."
- Clean this device with a clean cloth. Do not use any volatile chemicals.

♦ **Others**

- Never modify this device. Modification may cause the device not to detect, resulting in death or serious injury.
- Do not use this device to detect objects flying over the sensing area.
- Do not use this device to detect transparent objects, translucent objects or objects smaller than the specified minimum sensing objects.

1-3 Applicable Standards / Regulations

This device complies with the following standards / regulations.

<EU Directives>
EU Machinery Directive 98/37/EC, EMC Directive 2004/108/EC

<European Standards>
EN 61496-1 (Type 4), EN 55011

<International Standards>
IEC 61496-1 / 2 (Type 4), ISO 13849-1: 2006 (Category 4, PLe), IEC 61508-1 to 7 (SIL3)

<Japanese Industrial Standards (JIS)>
JIS B 9704-1 / 2 (Type 4), JIS B 9705-1 (Category 4), JIS C 0508 (SIL3)

<Standards in US / Canada)>
UL 61496-1 / 2 (Type 4), UL 508, UL 1998 (Class 2), CSA 61496-1 / 2 (Type 4), CSA C22.2 No.14

<Regulations in US>
OSHA 1910.212, OSHA 1910.217 (C), ANSI B11.1 to B11.19, ANSI/RIA 15.06

Regarding EU Machinery Directive, a Notified Body, TUV SUD, has certified with the type examination certificate. With regard to the standards in US / Canada, TUV SUD, has certified for cTUVus Mark.

<Reference>

The conformity to JIS, OSHA and ANSI for this device has been evaluated by ourselves.
The cTUVus Mark indicates compliance with both Canadian and US requirements.
This device conforms to the EMC Directive and the Machinery Directive. The CE Mark on the main body indicates that this device conforms to the EMC Directive.

⚠ WARNING

- In Japan, never use this device as a safety equipment for any press machine or shearing machine.
- When this device is used in a place other than the places shown above, be sure to confirm the standards or regulations applicable in each region or country before use.

1-4 Confirmation of Packed Contents

□ Sensor: Emitter, Receiver	1 pc. each
□ Test rod: **SF4C-TR25** (ø25 × 220mm)	1 pc.
□ Instruction Manual	1 pc.

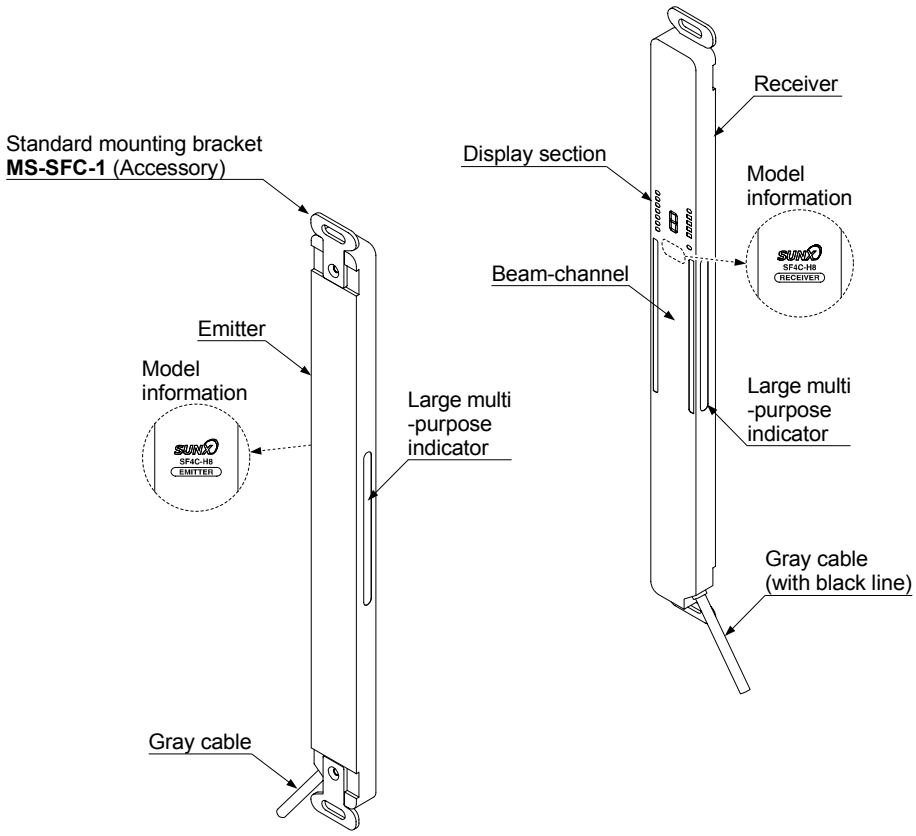
Chapter 2 Before Using This Device

2-1 Features

This device is the light curtain with the following features.

- No special controller is required.
- Cable type or pigtailed type is available.
- The control output (OSSD 1 / 2) is PNP / NPN output switching type.
- Large multi-purpose indicators (red, green) which are bright and easy-to-see are incorporated.
- Refer to "**6-2 Options**" for details of options.

2-2 Part Description



<Emitter>

It emits light to the receiver facing it. Furthermore, the status of the emitter and the receiver is indicated on its display section.

<Receiver>

It receives light from the emitter facing it. Simultaneously, it turns ON the control output (OSSD 1 / 2) when the all beam channels receive light from emitter, and it turns OFF the control output (OSSD 1 / 2) when one or more beam channels are blocked light. [Except when using the muting function (Note 1).]
Besides, the receiver displays its status on the display section.

Notes: 1) In case of using the muting function, muting sensors are required. Furthermore, incase desiring muting lamp, arrange them separately.

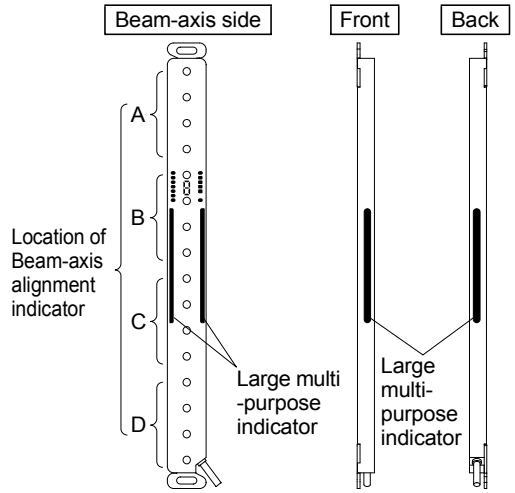
<Beam channel>

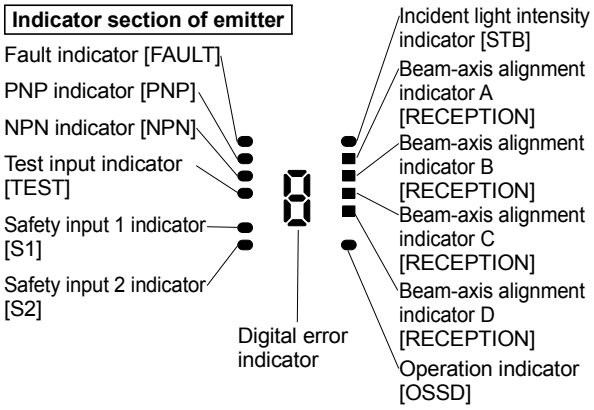
The light emitting elements of the emitter and the light receiving elements of the receiver are placed at the intervals of 20mm.

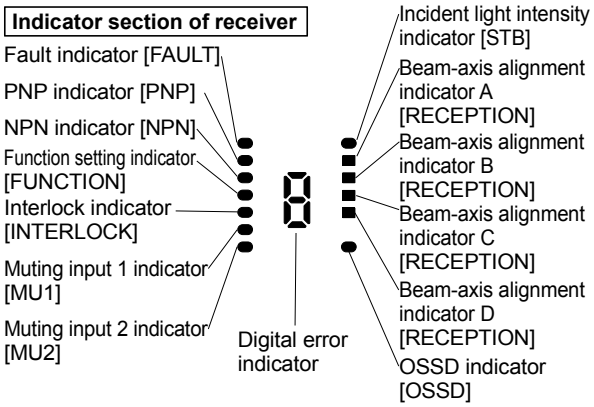
<Standard mounting bracket MS-SFC-1 (Accessory)>

The mounting brackets are attached to this device.
This brackets are to be used for mounting both emitter and receiver.

<Indicator section>




Indicator section of emitter
Fault indicator [FAULT]
PNP indicator [PNP]
NPN indicator [NPN]
Test input indicator [TEST]
Safety input 1 indicator [S1]
Safety input 2 indicator [S2]
Digital error indicator
Incident light intensity indicator [STB]
Beam-axis alignment indicator A [RECEPTION]
Beam-axis alignment indicator B [RECEPTION]
Beam-axis alignment indicator C [RECEPTION]
Beam-axis alignment indicator D [RECEPTION]
Operation indicator [OSSD]


Indicator section of receiver
Fault indicator [FAULT]
PNP indicator [PNP]
NPN indicator [NPN]
Function setting indicator [FUNCTION]
Interlock indicator [INTERLOCK]
Muting input 1 indicator [MU1]
Muting input 2 indicator [MU2]
Digital error indicator
Incident light intensity indicator [STB]
Beam-axis alignment indicator A [RECEPTION]
Beam-axis alignment indicator B [RECEPTION]
Beam-axis alignment indicator C [RECEPTION]
Beam-axis alignment indicator D [RECEPTION]
OSSD indicator [OSSD]

<Common to emitter and receiver>

Description		Function
Large multi-purpose indicator (Red / Green)		Lights up in red when the large multi-purpose indicator input is valid. Lights up in green when the large multi-purpose indicator input is valid. Turns OFF when the input is invalid.
Incident light intensity indicator (Green / Orange) [STB]		Lights up in green when stable light is received. Lights up in orange when unstable light is received. Turns OFF when light is blocked. (Note 1)
Beam-axis alignment indicator (Red / Green) [RECEPTION]	A	Lights up in red when device top receives light. Blinks in red when device top end receives light. Lights up in green when control output (OSSD 1 / 2) is ON.
	B	Lights up in red when device upper middle receives light. Lights up in green when control output (OSSD 1 / 2) is ON.
	C	Lights up in red when device lower middle receives light. Lights up in green when control output (OSSD 1 / 2) is ON.
	D	Lights up in red when device bottom receives light. Blinks in red when device bottom end receives light. Lights up in green when control output (OSSD 1 / 2) is ON.
Digital error indicator (Red)		Error contents are indicated when device is lockout.
Fault indicator (Yellow) [FAULT]		Lights up or blinks when fault occurs in the device.
PNP indicator (Orange) [PNP]		Lights up when PNP output is set.
NPN indicator (Orange) [NPN]		Lights up when NPN output is set.

<Emitter>

Description	Function
Operation indicator (Red / Green) [OSSD] (Note 2)	Lights up when device operation is as follows. [sequential operation to control output (OSSD 1 / 2)] Lights up in red when control output (OSSD 1 / 2) is OFF. Lights up in green when control output (OSSD 1 / 2) is ON.
Test input indicator (Orange) [TEST]	Lights up when test input is valid. Turns OFF when test input is invalid.
Safety input 1 indicator (Orange) [S1]	Lights up when safety input 1 is valid. Turns OFF when safety input 1 is invalid.
Safety input 2 indicator (Orange) [S2]	Lights up when the safety input 2 is valid. Turns OFF when the safety input 2 is invalid.

<Receiver>

Description	Function
OSSD indicator (Red / Green) [OSSD]	Lights up in red when control output (OSSD 1 / 2) is OFF. Lights up in green when control output (OSSD 1 / 2) is ON.
Function setting indicator (Orange) [FUNCTION]	Turns OFF
Interlock indicator (Yellow) [INTERLOCK]	Lights up when interlock is valid. Turns OFF when interlock is invalid.
Muting input 1 indicator (Orange) [MU1]	Lights up when muting input 1 is valid. Turns OFF when muting input 1 is invalid.
Muting input 2 indicator (Orange) [MU2]	Lights up when muting input 2 is valid. Turns OFF when muting input 2 is invalid.

Notes: 1) "When light is blocked" refers to the status that there exists any object blocking light in the sensing area.
2) Since the color of the operation indicator changes according to ON / OFF status of the control output (OSSD 1 / 2), the operation indicator is marked as "OSSD" on the device.
3) The description given in [ ] is marked on the device.

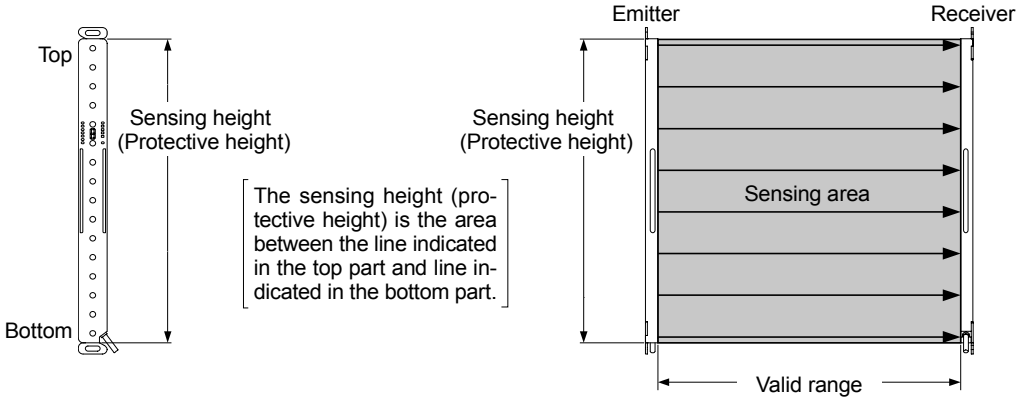
2-3 Protection Area

2-3-1 Sensing Area

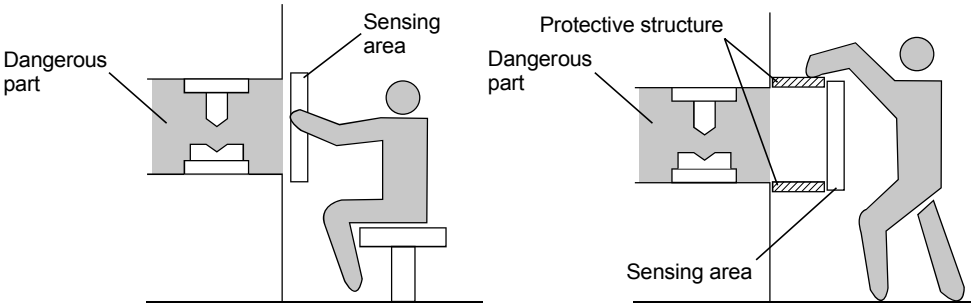
⚠ WARNING

- Be sure to install protection structure around the machine so that the operator must pass through the sensing area of this device to reach the dangerous parts of the machine.
  Furthermore, ensure that some part of the operator's body always remains in the sensing area when operation is done with the dangerous parts of the machine. Failure to do so can result in death or serious injury.
- Do not use any reflection type or recursive reflection type arrangement.
- Furthermore, never use this device facing several receivers towards one emitter or vice versa.

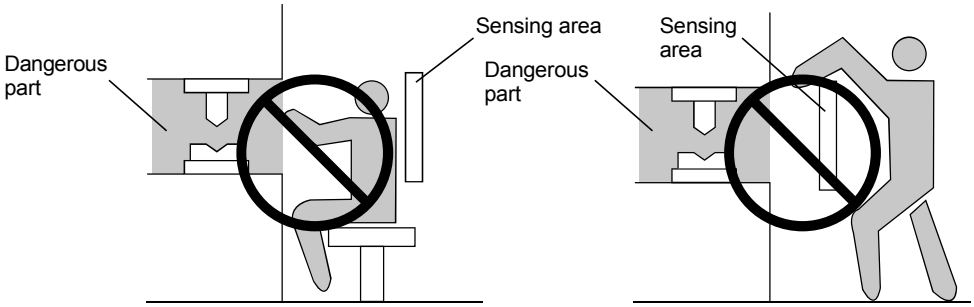
The sensing area is the zone formed by the sensing height (protective height) of the device and the valid range between the emitter and the receiver. The sensing height (protective height) is determined by the number of beam channels. Furthermore, the valid range can be 0.1 to 3m.
Take care that if the valid range is under 0.1m, malfunction may occur due to the optical structure.



<Example of correct installation>



<Example of incorrect installation>

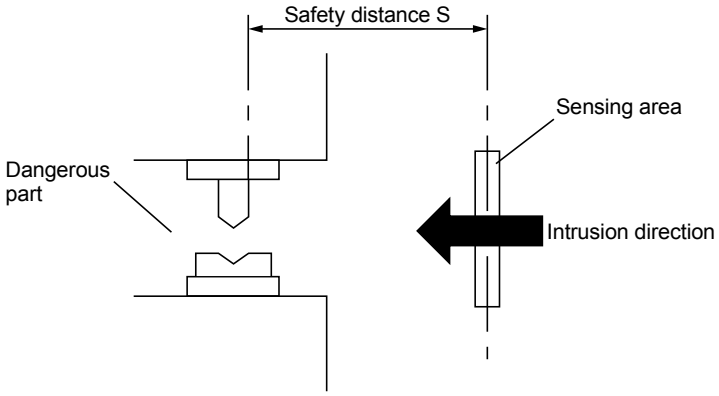


2-3-2 Safety Distance

⚠ WARNING

Calculate the safety distance correctly, and always maintain the distance which is equal to or greater than the safety distance, between the sensing area of this device and the dangerous parts of the machine. If the safety distance is miscalculated or if sufficient distance is not maintained, the machine will not stop quickly before reaching to the dangerous parts, which can result in death or serious injury.

The safety distance is the minimum distance that must be maintained between this device and the dangerous parts of the machine so that the machine can be stopped before a human body or an object can reach the dangerous parts.
The safety distance is calculated based on the equation described in the next page when a person moves perpendicular (normal intrusion) to the sensing area of the device.



⚠ WARNING

Before designing the system, refer to the relevant standards of the region where this device is to be used, and then install this device.
Furthermore, the equation described in the next pages is to be used only in case the intrusion direction is perpendicular to the sensing area. In case the intrusion direction is not perpendicular to the sensing area, be sure to refer to the relevant standard (regional standard, specification of the machine, etc.) for details of the calculation.

⚠ WARNING

The max. response time of the machine is from the point that the machine receives the halt signal from this device to the point that the dangerous parts of the machine stops. The max. response time of the machine should be timed with the machine to be actually used.

[For use in Europe (EU) (as EN 999)] (Also applicable to ISO 13855 / JIS B9715)
(For intrusion direction perpendicular to the sensing area)
<In case that the minimum sensing object is ø40mm or less>

● Equation 1 $S = K \times T + C$

S : Safety distance (mm)
Minimum required distance between the sensing area surface and the dangerous parts of the machine

K : Intrusion velocity of operator's body or object (mm/sec.)
Taken as 2,000 (mm/sec.) for calculation.

T : Response time of total equipment (sec.)
$T = T_m + T_{SF4C}$
T_m: Maximum halting time of machine (sec.)
T_{SF4C}: Response time of this device (sec.)

C : Additional distance calculated from the size of the minimum sensing object of the device (mm)
However, the value of C cannot be under 0.
$C = 8 \times (d - 14)$
d: Minimum sensing object diameter (mm)

<Reference>

● For calculating the safety distance S, there are the following five cases.
First, calculate by substituting the value K = 2,000 (mm/sec.) in the equation above. Then, classify the obtained value of S into three cases, 1) S < 100, 2) 100 ≤ S ≤ 500, and 3) S > 500. For Case 3) S > 500, recalculate by substituting the value K = 1,600 (mm/sec.). After that, classify the calculation result into two cases, 4) S ≤ 500 and 5) S > 500.
For details, refer to "Calculation example 1 For use in Europe."
● When this device is used in the "PSDI mode," an appropriate safety distance S must be calculated.
For details, be sure to refer to the standards or regulations applicable in each region or country.

<In case that the minimum sensing object is over ø40mm>

● Equation 1 $S = K \times T + C$

S : Safety distance (mm)
Minimum required distance between the sensing area surface and the dangerous parts of the machine

K : Intrusion velocity of operator's body or object (mm/sec.)
Taken as 1,600 (mm/sec.) for calculation.

T : Response time of total equipment (sec.)
$T = T_m + T_{SF4C}$
T_m: Maximum halting time of machine (sec.)
T_{SF4C}: Response time of this device (sec.)

C : Additional distance calculated from the size of the minimum sensing object of the device (mm)
$C = 850$ (mm)

<Calculation example>

● Calculation example 1: For use in Europe
(OFF response time: 7ms or less, minimum sensing object diameter: 25mm)

First, calculate with K = 2,000.

$S = K \times T + C$
$= K \times (T_m + T_{SF4C}) + 8 \times (d - 14)$
$= 2{,}000 \times (T_m + 0.007) + 8 \times (25 - 14)$
$= 2{,}000 \times T_m + 2{,}000 \times 0.007 + 8 \times 11$
$= 2{,}000 \times T_m + 14 + 88$
$= 2{,}000 \times T_m + 102$

If the result is:

1) In case S < 100 (mm)
Safety distance S is taken as 100 (mm)

2) In case 100 ≤ S ≤ 500 (mm)
Safety distance S is taken as $2{,}000 \times T_m + 102$ (mm)

3) In case S > 500 (mm)

$S = K' \times (T_m + T_{SF4C}) + 8 \times (d - 14)$
$= 1{,}600 \times (T_m + 0.007) + 8 \times (25 - 14)$
$= 1{,}600 \times T_m + 1{,}600 \times 0.007 + 8 \times 11$
$= 1{,}600 \times T_m + 11.2 + 88$
$= 1{,}600 \times T_m + 99.2$

then, calculate again.

If the result is:

4) In case S ≤ 500 (mm)
Safety distance S is taken as 500 (mm)

5) In case S > 500 (mm)
Safety distance S is taken as $1{,}600 \times T_m + 99.2$ (mm)

In case this device is installed in a system with a maximum halting time 0.1 (sec.)

$S = 2{,}000 \times T_m + 102$
$= 2{,}000 \times 0.1 + 102$
$= 302$

Since this value matches with the case 2) above, S is 302 (mm).

In case this device is installed in a system with a maximum halting time 0.4 (sec.)

$S = 2{,}000 \times T_m + 102$
$= 2{,}000 \times 0.4 + 102$
$= 902$

Since this value matches with the case 3) above,

$S = 1{,}600 \times T_m + 99.2$
$= 1{,}600 \times 0.4 + 99.2$
$= 739.2$

Since this value matches with the case 5) above, S is 739.2 (mm).

[For use in the United States of America (as per ANSI/RIA 15.06)]

● Equation 2 $D_S = K \times (T_S + T_C + T_{SF4C} + T_{bm}) + D_{pf}$

D_S : Safety distance (mm)
Minimum required distance between the sensing area surface and the dangerous parts of the machine

K : Intrusion speed {Recommended value in OSHA is 63 (inch/sec.) [≈ 1,600 (mm/sec.)]}
ANSI/RIA 15.06 does not define the intrusion speed "K". When determining K, consider possible factors including physical ability of operators.

T_S : Halting time calculated from the operation time of the control element (air valve, etc.) (sec.)

T_C : Maximum response time of the control circuit required for functioning the brake (sec.)

T_{SF4C}: Response time of this device (sec.)

T_{bm} : Additional halting time tolerance for the brake monitor (sec.)
The following equation holds when the machine is equipped with a brake monitor.
$T_{bm} = T_a - (T_S + T_C)$
Ta: Setting time of brake monitor (sec.)
When the machine is not equipped with a brake monitor, it is recommended that 20% or more of $(T_S + T_C)$ is taken as additional halting time.

D_{pf} : Additional distance calculated from the size of the minimum sensing object of the device (mm)
D_{pf} = 61.2mm
$D_{pf} = 3.4 \times (d - 0.276)$ (inch)
$\approx 3.4 \times (d - 7)$ (mm)
d: Minimum sensing object diameter 0.985 (inch) ≈ 25 (mm)

<Reference>

Since the calculation above is performed by taking 1 (inch) = 25.4 (mm), there is a slight difference between the representation in (mm) and that in (inch).
Refer to the relevant standard for the details.

<Calculation example>

● Calculation example 2: For use in the United States of America
[OFF response time: 7ms or less, minimum sensing object diameter: 0.985 (inch) ≈ 20 (mm)]

$S = K \times (T_S + T_C + T_{SF4C} + T_{bm}) + D_{pf}$
$= 63 \times (T_a + 0.007) + 3.4 \times (d - 0.276)$ (inch)
$= 63 \times (T_a + 0.007) + 3.4 \times (0.985 - 0.276)$
$= 63 \times T_a + 63 \times 0.007 + 3.4 \times 0.709$
$= 63 \times T_a + 0.441 + 2.4106$
$= 63 \times T_a + 2.8516$
$\approx 63 \times T_a + 2.85$ (inch)

In case this device is installed in a system with a maximum halting time 0.1 (sec.)
$S = 63 \times T_a + 2.85$
$= 63 \times 0.1 + 2.85$
$= 9.15$ (inch)
≈ 232.41 (mm)

Hence, as per the calculations S is 232.4 (mm).

<Reference>

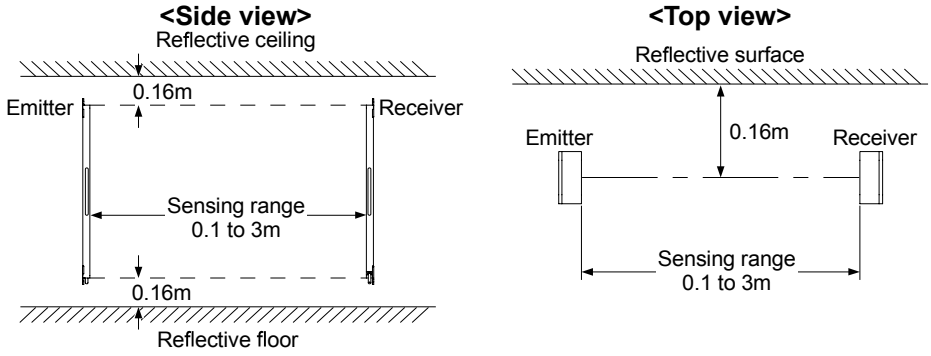
Since the calculation above is performed by taking 1 (inch) = 25.4 (mm), there is a slight difference between the representation in (mm) and that in (inch).
Refer to the relevant standard for the details.

2-3-3 Influence of Reflective Surfaces

⚠ WARNING

If there exists a reflective surface in the place where this device is to be installed, make sure to install this device so that reflected light from the reflective surface does not enter into the receiver, or take countermeasures such as painting, masking, roughening, or changing the material of the reflective surface, etc. Failure to do so may cause the device not to detect, resulting in death or serious injury.

Install this device at a distance of at 0.16m or more from reflective surfaces such as metal walls, floors, ceilings, sensing objects, covers, panels or glass surfaces.



2-3-4 Device Placement

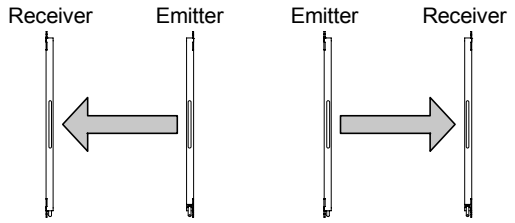
This is the configuration when two or more sets of emitter and receiver facing each other are placed. It is used for system evaluation in case of addition of equipment. Perform an operation test by referring to "**2-6-2 Operation Test**."

⚠ WARNING

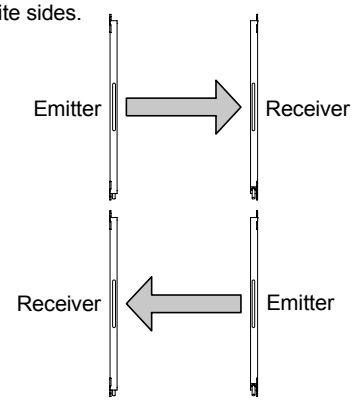
- Refer to the examples of device placement given below and understand them thoroughly before installing the devices.
  Improper sensor placement could cause device malfunction, which can result in death or serious injury.
- If this device is used in multiple sets, arrange them to avoid mutual interference.
  If mutual interference occurs, it can result in death or serious injury.

<Example of device placement>

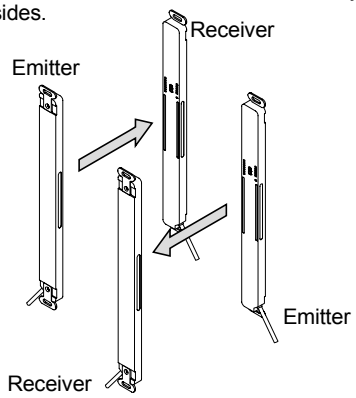
1) Install the emitter and the receiver back to back.



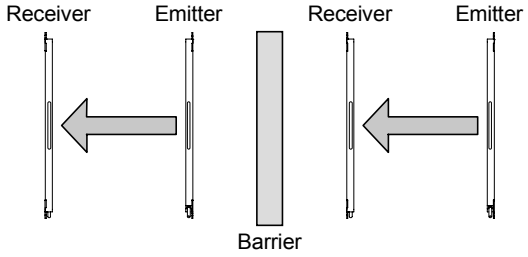
2) Arrange the emitter and the receiver vertically on opposite sides.



3) Arrange the emitter and the receiver horizontally on opposite sides.



4) Install a barrier



<Reference>

The above figures are just examples of device placement. If there are any questions or problems, please contact our office.

2-4 Mounting

2-4-1 Mounting of the Mounting Bracket

⚠ CAUTION

- Do not apply the load such as forced bending to the cable of this device. Applying improper load could cause the wire breakage.
- The minimum bending radius of the cable is R6mm. Mount the device with considering the cable bending radius.

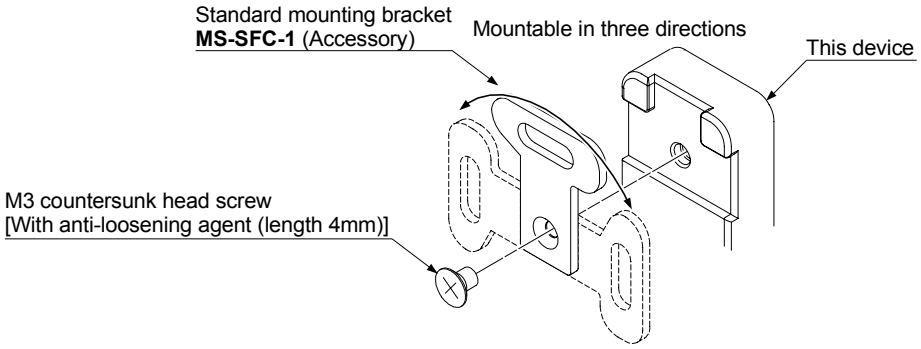
<Reference>

- Mount the emitter and the receiver at the same level and parallel to each other. The effective aperture angle of this device is ±2.5° or less at a sensing distance of 3m.
- Unless otherwise specified, the following mounting procedure is common for both emitter and receiver. For the preparation of the mounting, prepare the mounting holes on the mounting surface by referring to "**6-3 Dimensions**."

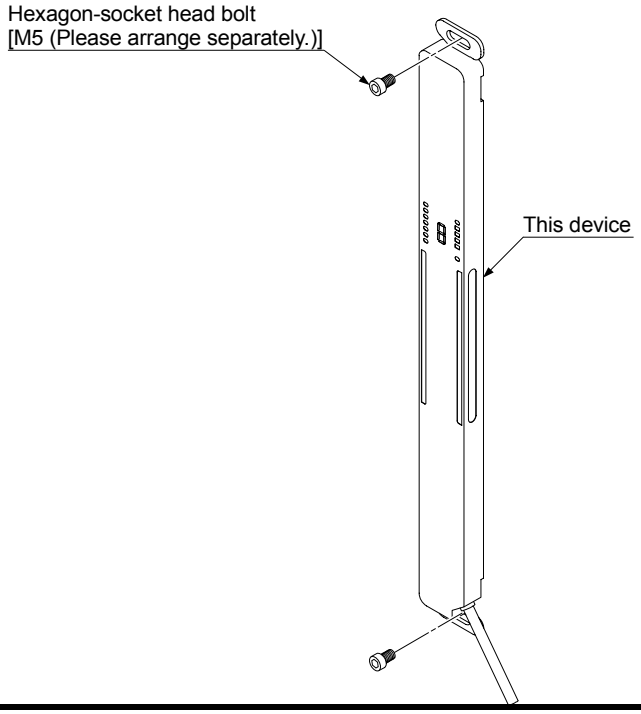
<In case of using standard mounting bracket MS-SFC-1 (Accessory)>

- Direction of the standard mounting bracket **MS-SFC-1** which is attached to this device can be changed depending on the mounting position of the device.

1. Remove the M3 countersunk head screw [with anti-loosening agent (length 4mm)] which is attached to the back of the device.
2 Decide the direction of the standard mounting bracket.
3. Tighten with the M3 countersunk head screw [with anti-loosening agent (length 4mm)].
   The tightening torque should be 0.3 N·m.



- Install the standard mounting brackets in the mounting surface with two hexagon-socket head bolts [M5 (please arrange separately)].



2-5 Wiring

⚠ WARNING

- Earth the machine or the support where the device is mounted on to frame ground (F.G.).
  Failure to do so could cause the malfunction of the product by noise, resulting in death or serious injury. Furthermore, the wiring should be done in a metal box connected to the frame ground (F.G.).
- Take countermeasure against the system to be applied for this device so as not to carry out the dangerous performance caused by the earth failure.
  Failure to do so could cause invalid for the system stop, resulting in death or serious injury.
- In order that the output is not turned ON due to earth fault of the control output (OSSD 1 / 2) wires, be sure to ground to 0V side (PNP output) / +V side (NPN output).

⚠ CAUTION

Make sure to insulate the ends of the unused lead wires.

<Reference>

Use a safety relay unit or an equivalent control circuit in safety for FSD.

2-5-1 Power Supply Unit

⚠ CAUTION

Wire correctly using a power supply unit which conforms to the laws and standards of the region where this device is to be used.
If the power supply unit is non-conforming or the wiring is improper, it can cause damage or malfunction of this device.

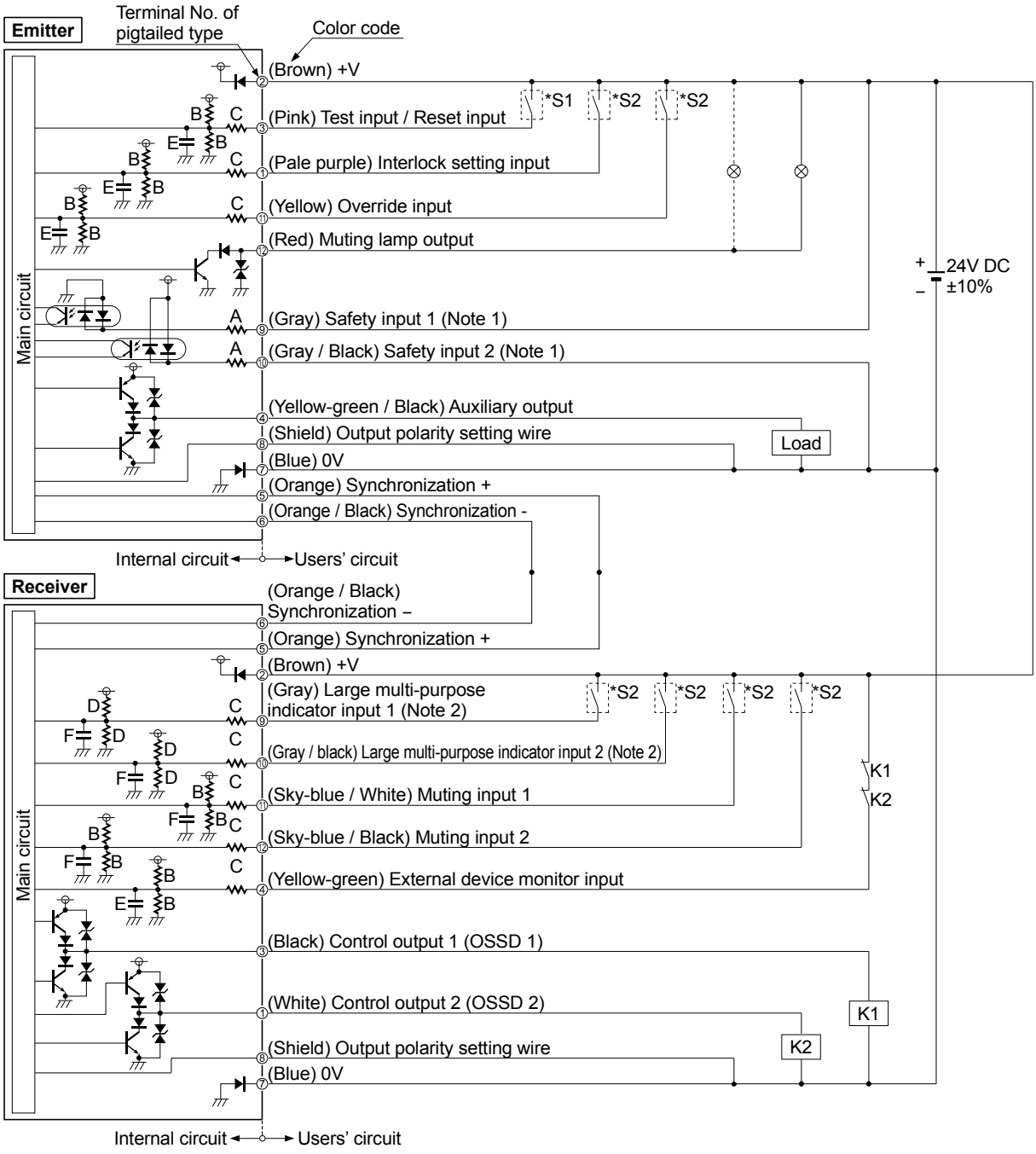
<Reference>

A specialist who has the required electrical knowledge should perform the wiring.
The power supply unit must satisfy the conditions given below.

1) Power supply unit authorized in the region where this device is to be used.
2) Power supply unit SELV (safety extra low voltage) / PELV (protected extra low voltage) conforming to EMC Directive and Low-voltage Directive (only for requiring CE marking conformation).
3) Power supply unit conforming to the Low-voltage Directive and with an output of 100VA or less.
4) The frame ground (F.G.) terminal must be connected to the ground when using a commercially available switching regulator.
5) Power supply unit with an output holding time of 20ms or more.
6) In case a surge is generated, take countermeasures such as connecting a surge absorber to the origin of the surge.
7) Power supply unit corresponding to CLASS 2 (only for requiring cTUVus Mark conformation).

2-5-2 I/O Circuit Diagrams and Output Waveform

<For PNP output>



<Reference>

K1, K2: External device
(Forced guided relay or magnetic contactor)
Resistance A: 3kΩ, Resistance B: 6.8kΩ
Resistance C: 470Ω, Resistance D: 47kΩ
Condenser E: 0.47μF
Condenser F: 0.1μF

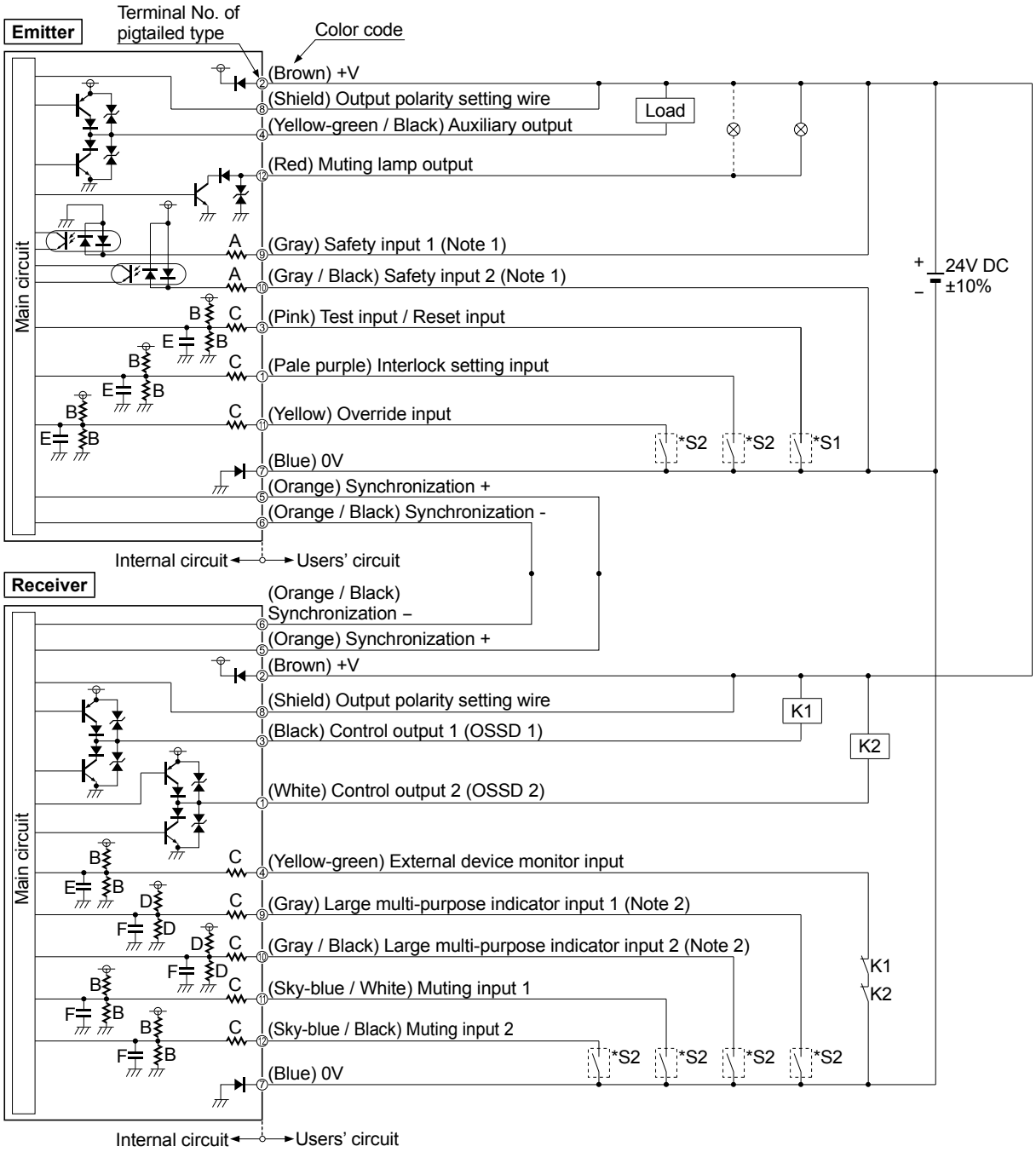
*S1, S2

Switch S1
- Test input / Reset input
  For manual reset: Vs to Vs - 3.5V (sink current 5mA or less): OFF (Note 3)
  Open: ON
  For auto reset: Vs to Vs - 3.5V (sink current 5mA or less): ON (Note 3)
  Open: OFF

Switch S2
- Override input, Interlock setting input, Large multi-purpose indicator input 1 / 2, Muting input 1 / 2 and External device monitor input
  Vs to Vs - 3.5V (sink current 5mA or less): Valid (Note 3), Open: Invalid

Notes 1) For wiring of the safety input 1 wire (gray) and the safety input 2 wire (gray / black), refer to "**2-5-7 Wiring Configuration for Valid Safety Input Function**."
2) Large multi-purpose indicator lights up in red when connecting large multi-purpose indicator input 1 wire (grey) and +V, and large multi-purpose indicator lights up in green when connecting large multi-purpose indicator input 2 wire (grey / black) and +V.
3) Vs is the applying supply voltage.

<For NPN output>



<Reference>

K1, K2: External device
(Forced guided relay or magnetic contactor)
Resistance A: 3kΩ, Resistance B: 6.8kΩ
Resistance C: 470Ω, Resistance D: 47kΩ
Condenser E: 0.47μF
Condenser F: 0.1μF

*S1, S2

Switch S1
- Test input / Reset input
  For manual reset: 0 to +2.5V (source current 5mA or less): OFF, Open: ON
  For auto reset: 0 to +2.5V (source current 5mA or less): ON, Open: OFF

Switch S2
- Override input, Interlock setting input, Large multi-purpose indicator input 1 / 2, Muting input 1 / 2 and External device monitor input
  0 to +2.5V (source current 5mA or less): Valid, Open: Invalid

Notes 1) For wiring of the safety input 1 wire (gray) and the safety input 2 wire (gray / black), refer to "**2-5-7 Wiring Configuration for Valid Safety Input Function**."
2) Large multi-purpose indicator lights up in red when connecting large multi-purpose indicator input 1 wire (grey) and 0V, and large multi-purpose indicator lights up in green when connecting large multi-purpose indicator input 2 wire (grey / black) and 0V.

<Output waveform [when control output (OSSD 1 / 2) is ON]>

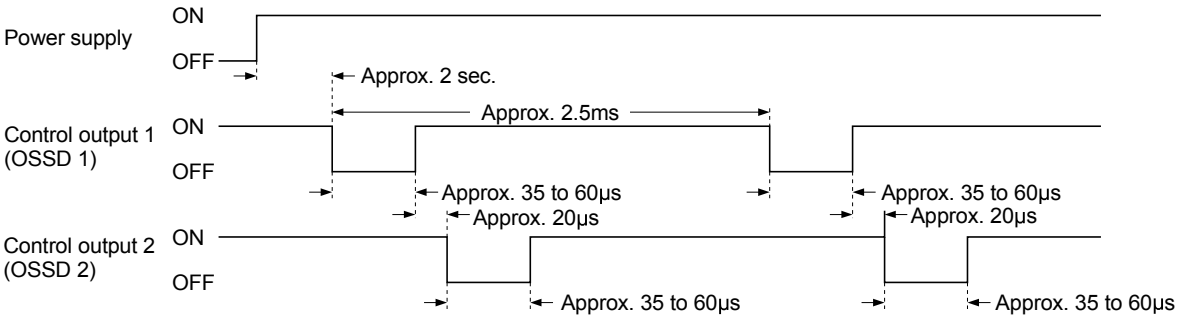
Since the receiver performs the self-diagnosis of the output circuit when the device is in light receiving status (ON status), the output transistor becomes OFF status periodically. (Refer to the figure below.)

When the OFF signal is fed back, the receiver judges the output circuit as normal. When the OFF signal is not fed back, the receiver judges either the output circuit or wiring as error, and the control output (OSSD 1 / 2) maintains OFF status.

⚠ CAUTION

Perform the wiring with paying attention to the input response time of the machine to be connected to this device, since the OFF signal of this device might cause malfunction.

<Time chart>



2-5-3 Wiring / Connecting Procedures and Terminal Arrangement

Connect the mating cable (with connector on one end or connector on both ends) to the pigtailed type of this device (emitter and receiver) according to the customer's application referring to the terminal arrangement given below. In addition, in case of the cable type (emitter and receiver) as well, wire the cables according to the customer's application referring to the terminal arrangement given below.

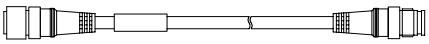
⚠ WARNING

- When extending the cable, use the exclusive cable up to the total length of 40.5m or less (for each emitter / receiver). Extending the cable longer than 40.5m may cause malfunction, which can result in death or serious injury.
- In case of using the muting lamp, a total length should be 30.5m or less (for each emitter / receiver).
- When the synchronization cable is extended with a cable other than exclusive cable, use a 0.2mm^2 or more shielded twisted pare cable.

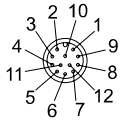
<Cable with connector on one end>

A side

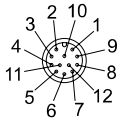
<Cable with connector on both ends>

A side  B side

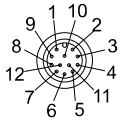
<Terminal arrangement of A side>



<Terminal arrangement of A side>



<Terminal arrangement of B side>



	Cable / Connector color	Terminal No.	Color code	Description
Emitter	Gray / Gray	1	Pale purple	Interlock setting input
		2	Brown	+V
		3	Pink	Test input / Reset input
		4	Yellow-green / Black	Auxiliary output
		5	Orange	Synchronization +
		6	Orange / Black	Synchronization –
		7	Blue	0V
		8	(Shield)	Output polarity setting wire
		9	Gray	Safety input 1
		10	Gray / Black	Safety input 2
		11	Yellow	Override input
		12	Red	Muting lamp output
Receiver	Gray (with black line) / Black	1	White	Control output 2 (OSSD 2)
		2	Brown	+V
		3	Black	Control output 1 (OSSD 1)
		4	Yellow-green	External device monitor input
		5	Orange	Synchronization +
		6	Orange / Black	Synchronization –
		7	Blue	0V
		8	(Shield)	Output polarity setting wire
		9	Gray	Large multi-purpose indicator input 1
		10	Gray / Black	Large multi-purpose indicator input 2
		11	Sky-blue / White	Muting input 1
		12	Sky-blue / Black	Muting input 2

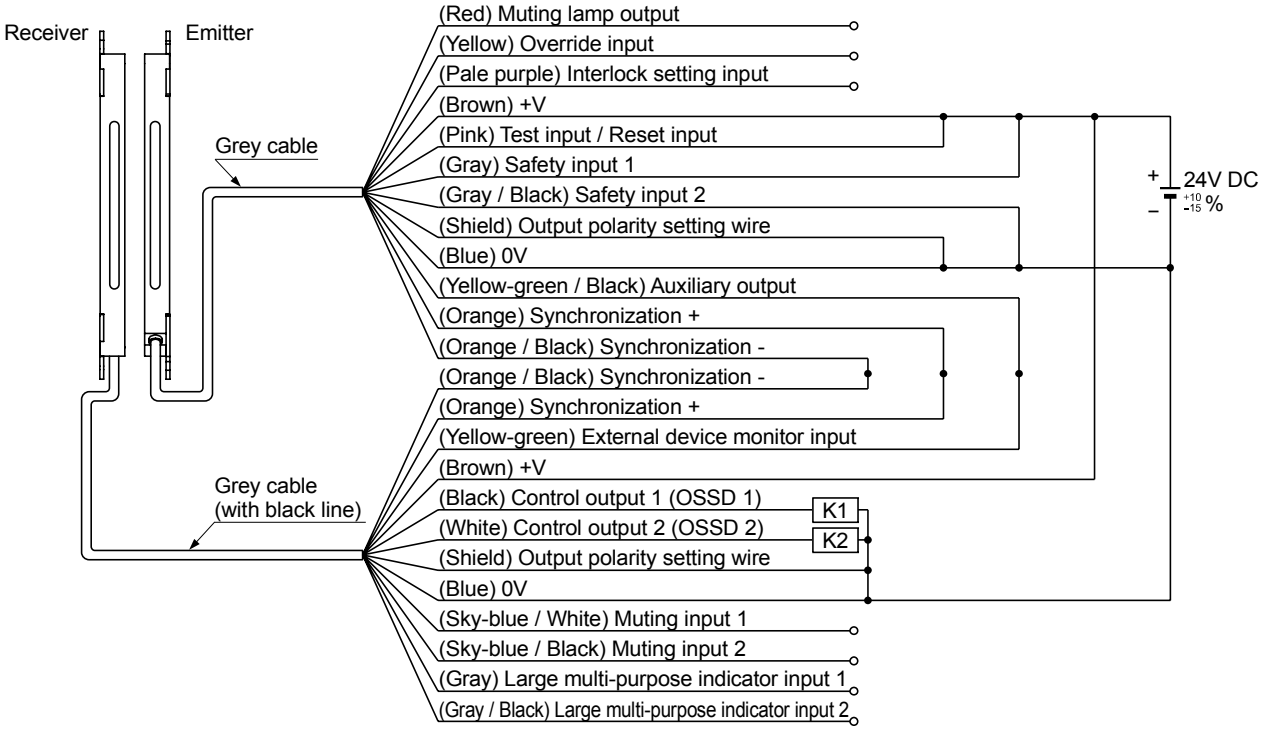
<Reference>

- The connectors can be distinguished from their colors as follows:
  Connector for emitter: Gray, connector for receiver: Black
- For details of the cable with connector on one end and the cable with connector on both ends, refer to "**6-2 Options**."

2-5-4 Basic Wiring

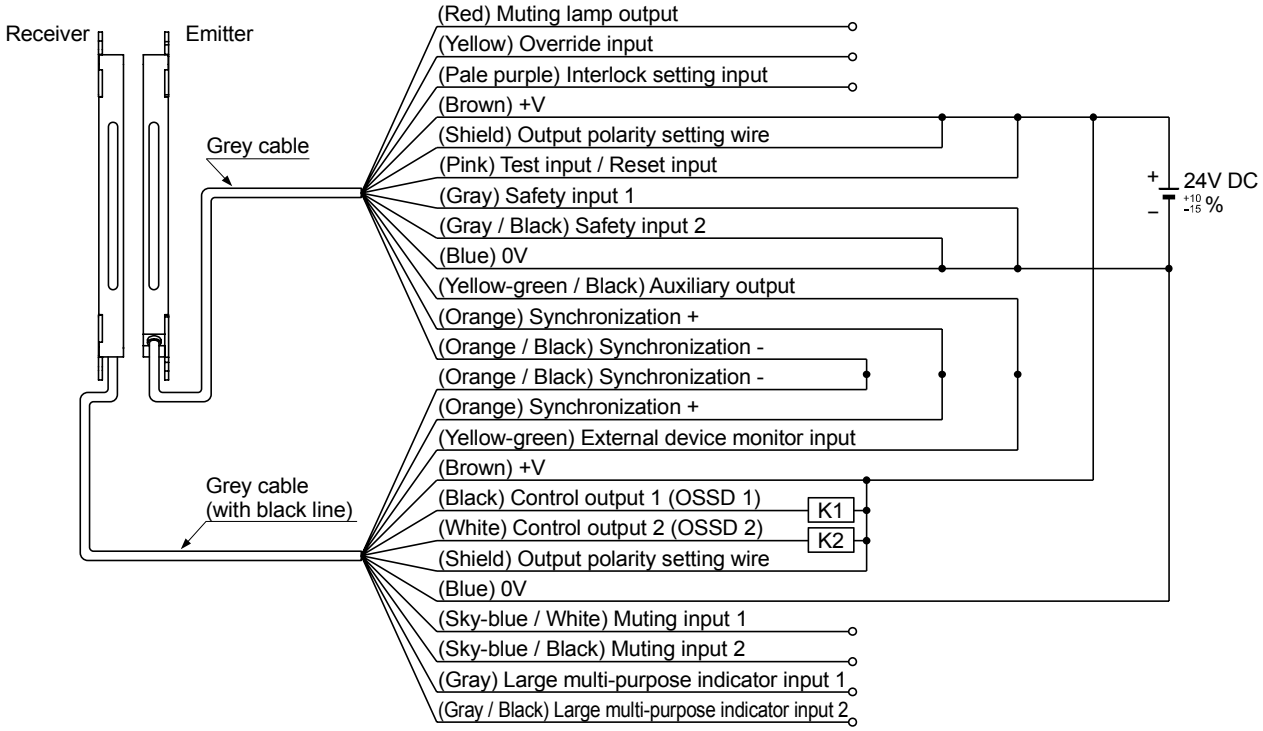
This is the general configuration using one set of the emitter and receiver facing each other. The control output (OSSD 1 / 2) turns OFF if the light is blocked, while it automatically turns ON if receives the light.
The auxiliary output is used to invalid the external device monitor function. The auxiliary output cannot be connected to external devices.

<For PNP output>



Interlock function	Invalid (Auto-reset)
External device monitor function	Invalid
Auxiliary output	Cannot be used

<For NPN output>

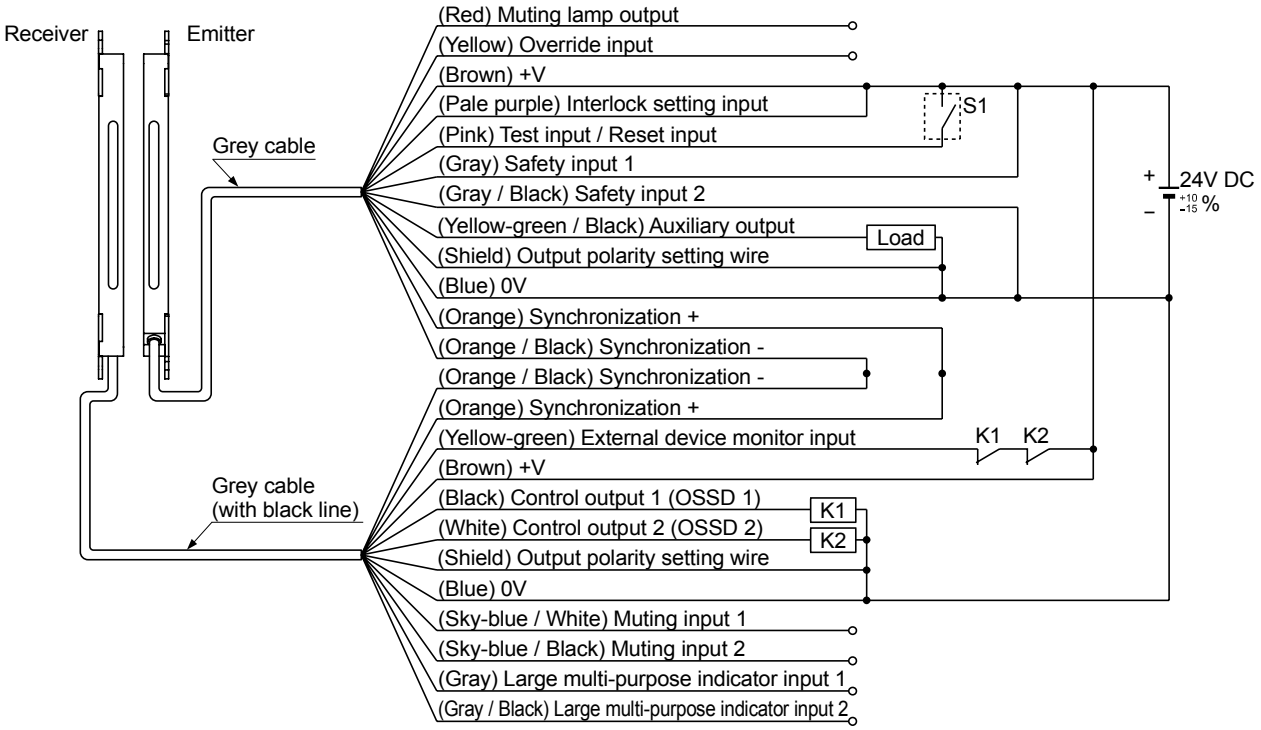


Interlock function	Invalid (Auto-reset)
External device monitor function	Invalid
Auxiliary output	Cannot be used

2-5-5 Wiring for Manual Reset (Interlock is Valid) (Wiring Example of the Control Category 4)

This is the general configuration using one set of the emitter and receiver facing each other. The control output (OSSD 1 / 2) turns OFF if the light is blocked.

<For PNP output>



Interlock function	Valid (Manual reset)
External device monitor function	Valid
Auxiliary output	Can be used

The device output is selected depending on the connecting state of the output polarity setting wire (shield). Incorrect wiring may cause the lockout state.

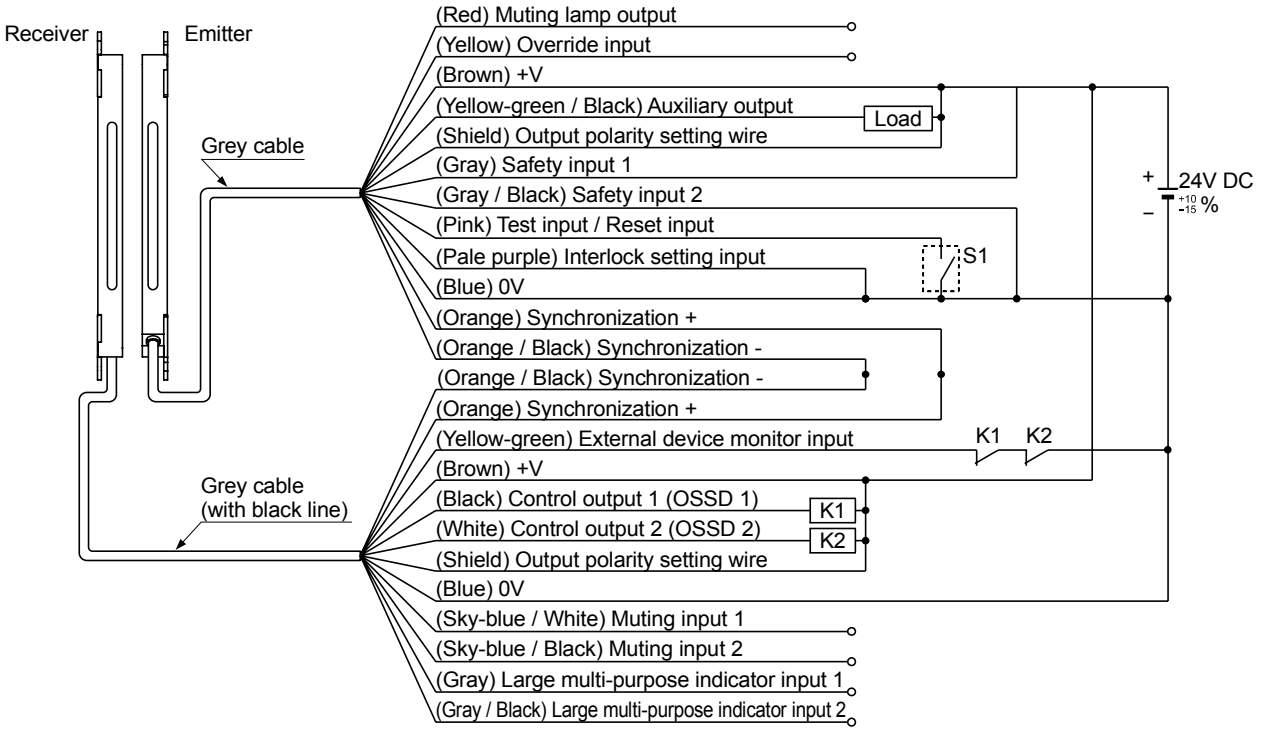
* Symbols

Switch S1
- Test input / Reset input
  Vs to Vs - 3.5V (sink current 5mA or less): OFF (Note 1), Open: ON

K1, K2: External device (Forced guided relay or magnetic contactor)

Notes: 1) Vs is the applying supply voltage.
2) For resetting, refer to "**3-2 Interlock Function**."

<For NPN output>



Interlock function	Valid (Manual reset)
External device monitor function	Valid
Auxiliary output	Can be used

The device output is selected depending on the connecting state of the output polarity setting wire (shield). Incorrect wiring may cause the lockout state.

* Symbols

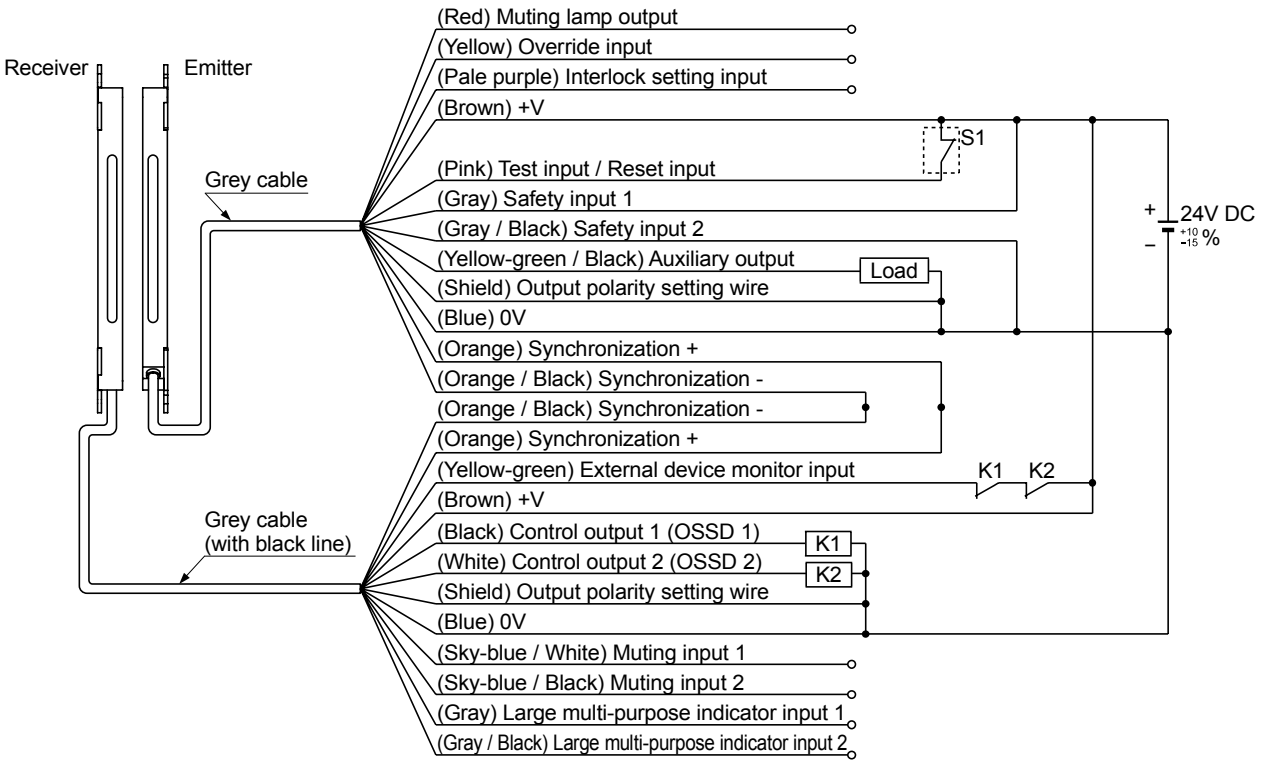
Switch S1
- Test input / Reset input
  0 to +2.5V (source current 5mA or less): OFF, Open: ON

K1, K2: External device (Forced guided relay or magnetic contactor)

Note: For resetting, refer to "**3-2 Interlock Function**."

2-5-6 Wiring for Auto Reset (Interlock is Invalid) (Wiring Example of the Control Category 4)

<For PNP output>



Interlock function	Invalid (Auto reset)
External device monitor function	Valid
Auxiliary output	Can be used

The device output is selected depending on the connecting state of the output polarity setting wire (shield). Incorrect wiring may cause the lockout state.

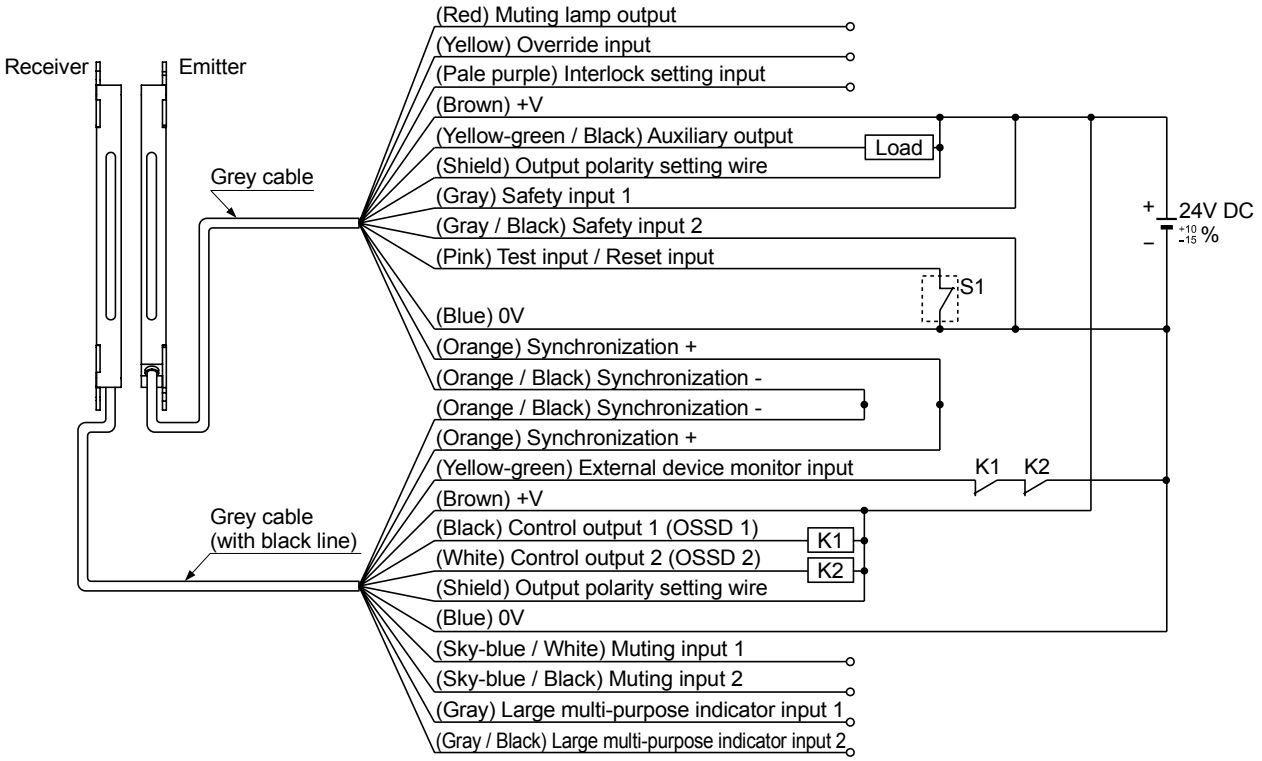
* Symbols

Switch S1
- Test input / Reset input
  Vs to Vs - 3.5V (sink current 5mA or less): ON (Note 1), Open: OFF

K1, K2: External device (Forced guided relay or magnetic contactor)

Notes: 1) Vs is the applying supply voltage.
2) For resetting, refer to "**3-2 Interlock Function**."

<For NPN output>



Interlock function	Invalid (Auto reset)
External device monitor function	Valid
Auxiliary output	Can be used

The device output is selected depending on the connecting state of the output polarity setting wire (shield). Incorrect wiring may cause the lockout state.

* Symbols

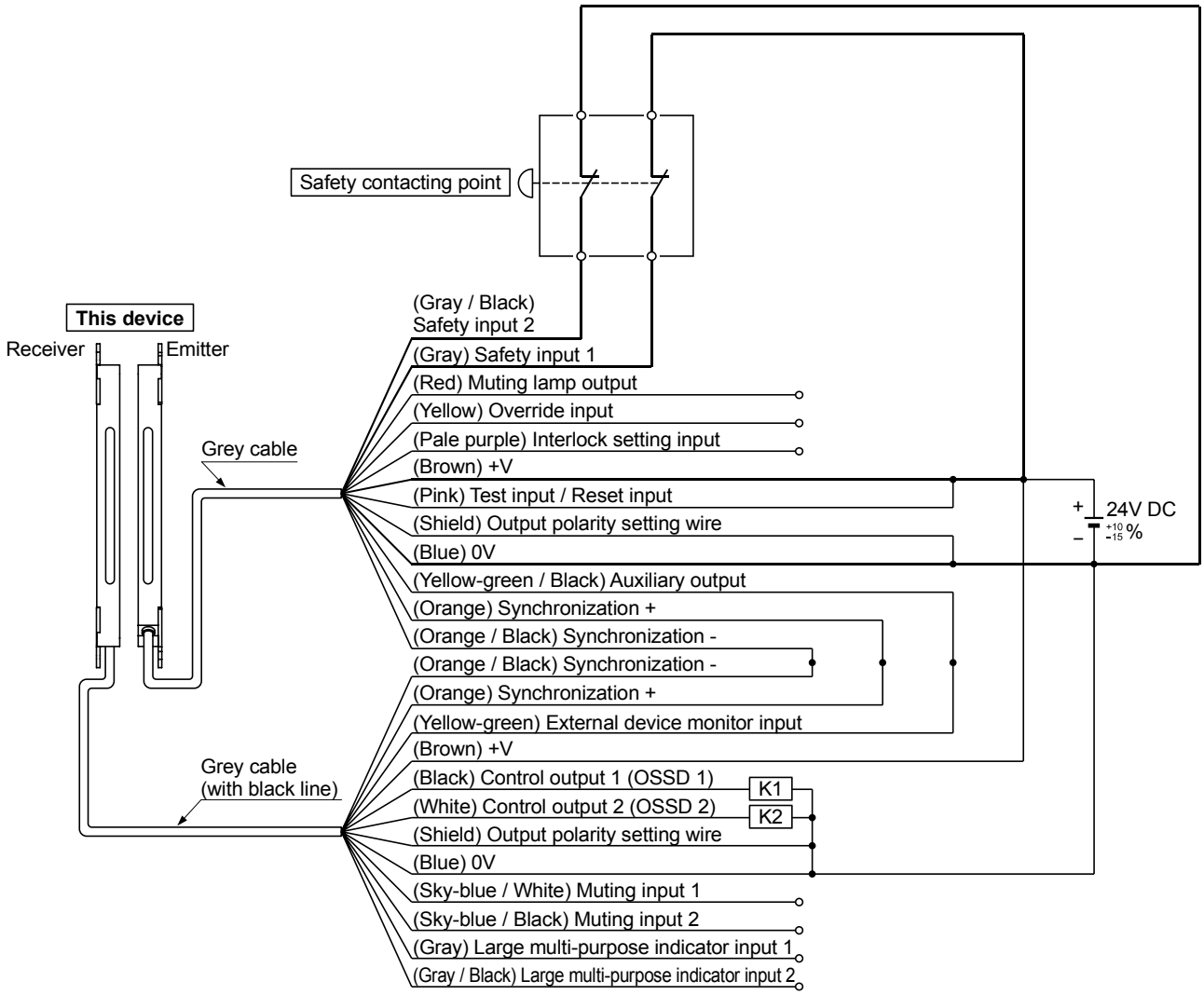
Switch S1
- Test input / Reset input
  0 to +2.5V (source current 5mA or less): ON, Open: OFF

K1, K2: External device (Forced guided relay or magnetic contactor)

Note: For resetting, refer to "**3-2 Interlock Function**."

2-5-7 Wiring Configuration for Valid Safety Input Function (Wiring Example of the Control Category 4)

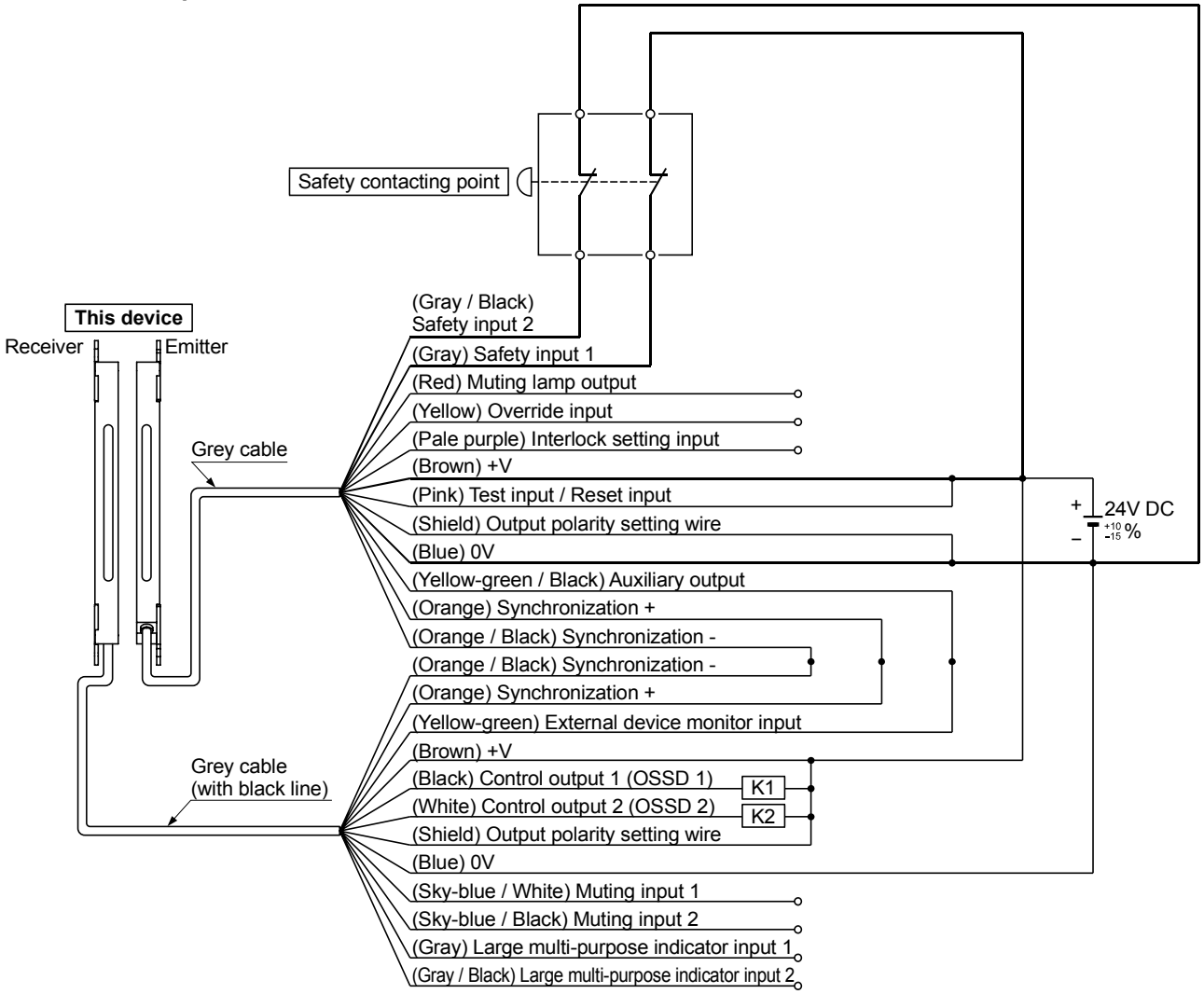
The safety contacting point can be connected to safety input 1 wire (gray) and the safety input 2 wire (gray / black) of the emitter.
Refer to "**3-4 Safety Input Function**" for detail of safety input function.
<For PNP output>



Interlock function	Invalid (Auto-reset)
External device monitor function	Invalid
Auxiliary output	Cannot be used

- Safety input
  Short-circuit (sink current 5 to 10mA), Source current 5 to 10mA: Valid
  Open: Invalid

<For NPN output>



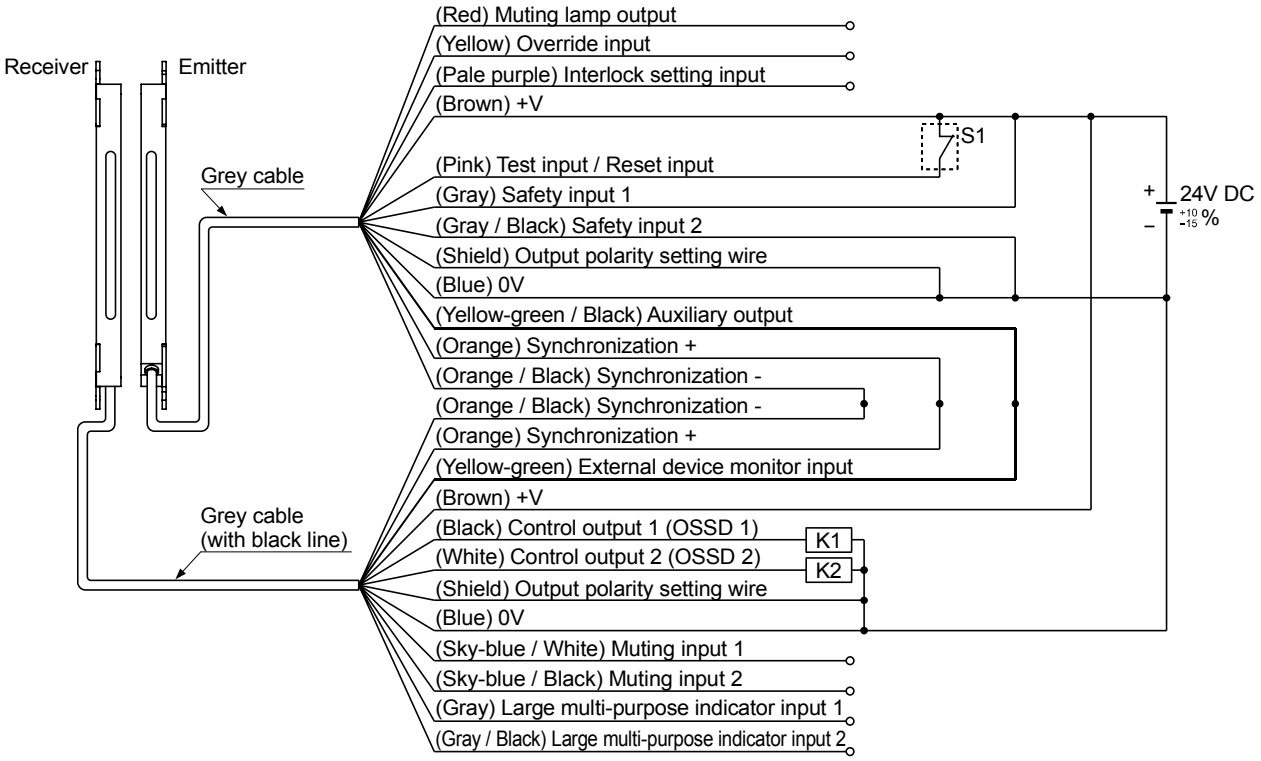
Interlock function	Invalid (Auto-reset)
External device monitor function	Invalid
Auxiliary output	Cannot be used

- Safety input
  Short-circuit (sink current 5 to 10mA), Source current 5 to 10mA: Valid
  Open: Invalid

2-5-8 Wiring Configuration for Invalid External Device Monitor Function (Wiring Example of the Control Category 4)

This is the configuration for connecting auxiliary output and external device monitor input. The auxiliary output cannot be connected to external devices.

<For PNP output>



Interlock function	Invalid (Auto reset)
External device monitor function	Invalid
Auxiliary output	Cannot be used

The device output is selected depending on the connecting state of the output polarity setting wire (shield). Incorrect wiring may cause the lockout state.

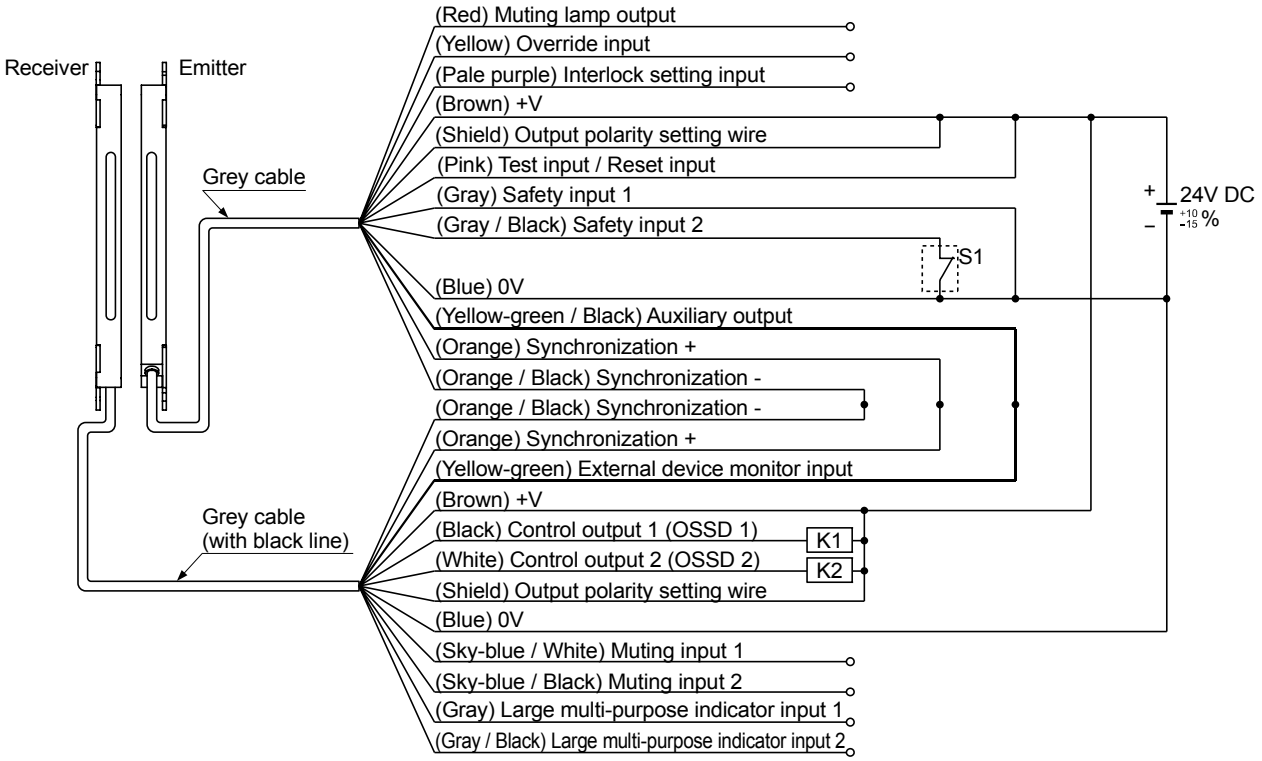
* Symbols

Switch S1
- Test input / Reset input
  Vs to Vs - 3.5V (sink current 5mA or less): ON (Note), Open: OFF

K1, K2: External device (Forced guided relay or magnetic contactor)

Note: Vs is the applying supply voltage.

<For NPN output>



Interlock function	Invalid (Auto reset)
External device monitor function	Invalid
Auxiliary output	Cannot be used

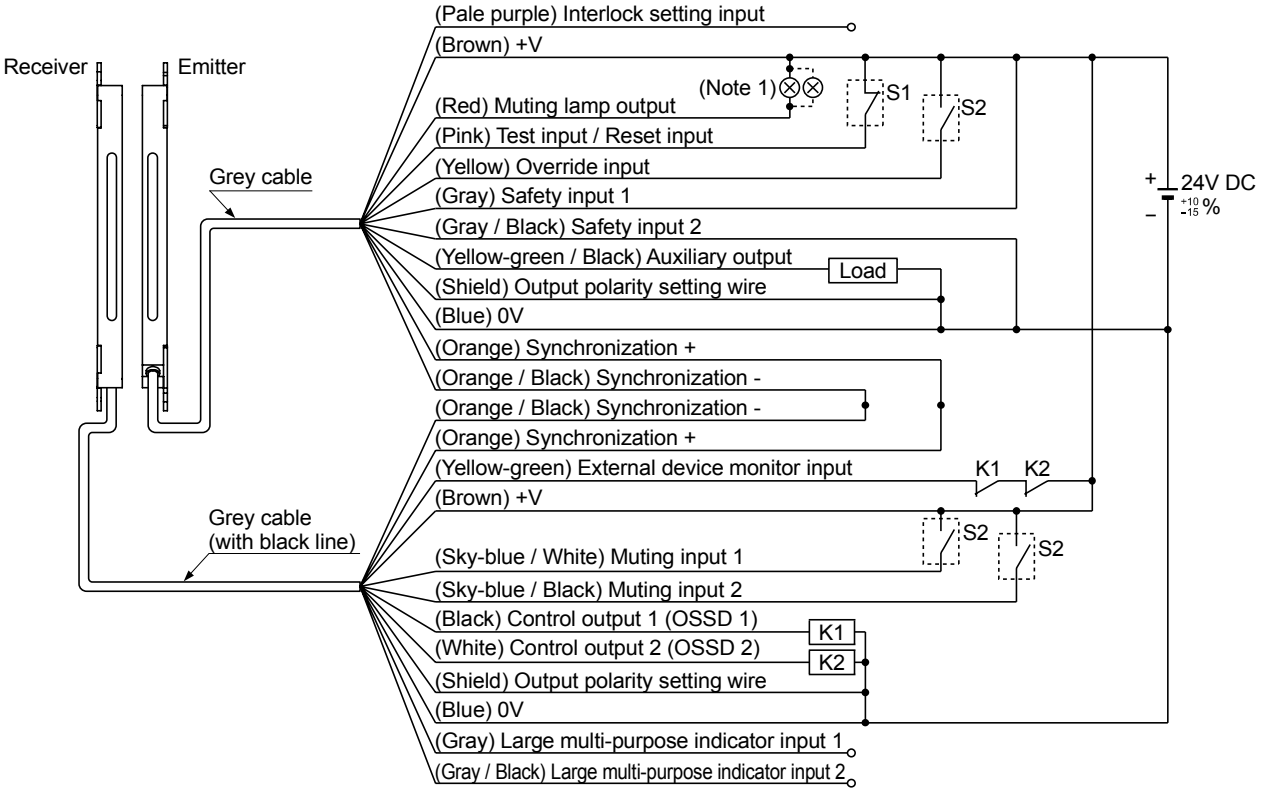
The device output is selected depending on the connecting state of the output polarity setting wire (shield). Incorrect wiring may cause the lockout state.

* Symbols

Switch S1
● Test input / Reset input
0 to +2.5V (source current 5mA or less): ON, Open: OFF
K1, K2: External device (Forced guided relay or magnetic contactor)

2-5-9 Wiring Configuration for Valid Muting Function (Wiring Example of the Control Category 4)

<For PNP output>



Interlock function	Invalid (Auto reset)
External device monitor function	Valid
Auxiliary output	Can be used

The device output is selected depending on the connecting state of the output polarity setting wire (shield). Incorrect wiring may cause the lockout state.

* Symbols

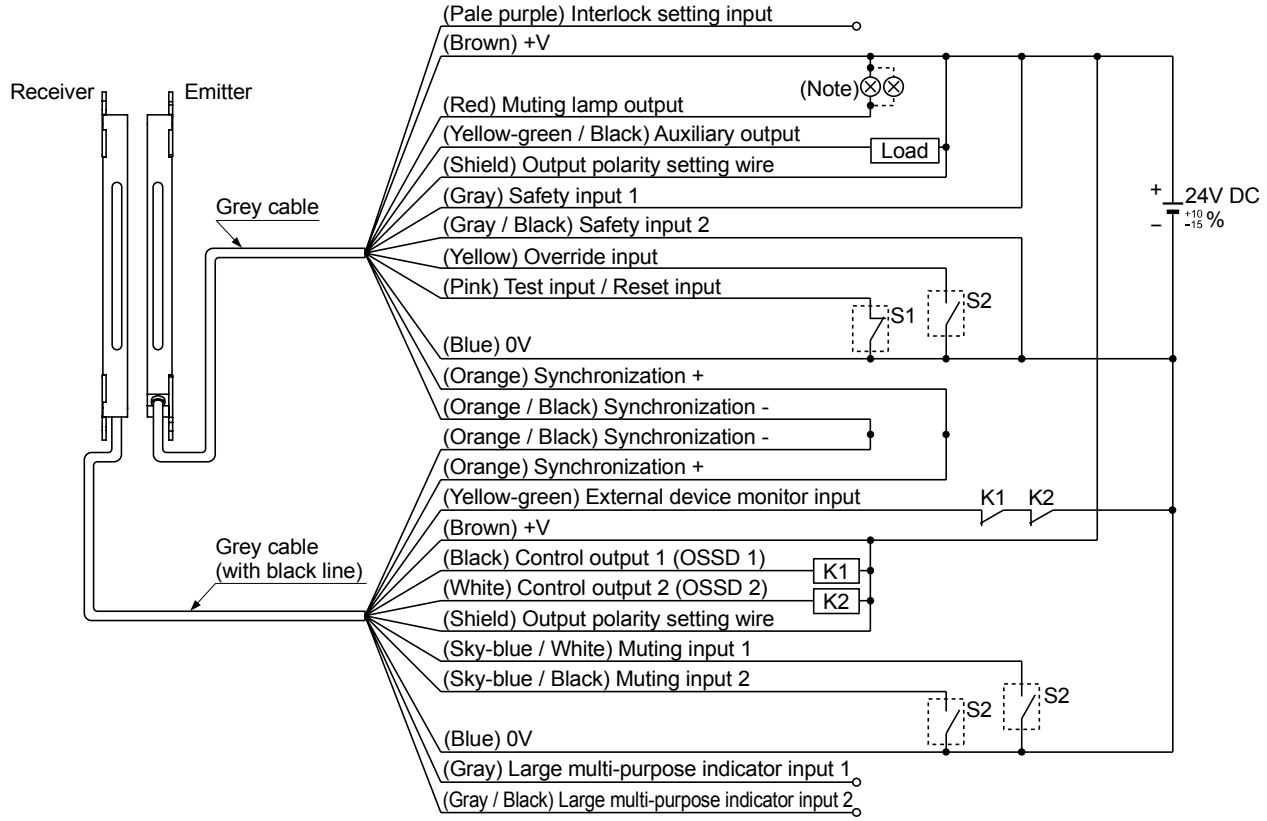
Switch S1
- Test input / Reset input
  Vs to Vs - 3.5V (sink current 5mA or less): ON (Note 2), Open: OFF

Switch S2
- Muting input, Override input
  Vs to Vs - 3.5V (sink current 5mA or less): Valid (Note 2), Open: Invalid

K1, K2: External device (Forced guided relay or magnetic contactor)

Notes: 1) The incandescent lamp or LED with total 6W or less shall be used when connecting lamp to the muting lamp output.
2) Vs is the applying supply voltage.

<For NPN output>



Interlock function	Invalid (Auto reset)
External device monitor function	Valid
Auxiliary output	Can be used

The device output is selected depending on the connecting state of the output polarity setting wire (shield). Incorrect wiring may cause the lockout state.

* Symbols

Switch S1
- Test input / Reset input
  0 to +2.5V (source current 5mA or less): ON, Open: OFF

Switch S2
- Muting input, Override input
  0 to +2.5V (source current 5mA or less): Valid, Open: Invalid

K1, K2: External device (Forced guided relay or magnetic contactor)

Note: The incandescent lamp or LED with total 6W or less shall be used when connecting to lamp the muting lamp output.

2-6 Adjustment

2-6-1 Beam-axis Alignment

1. Turn ON the power supply unit of this device.

2. Check that the digital error indicator (red) and the fault indicator (yellow) of the emitter and the receiver are OFF respectively.
   - If the digital error indicator (red) or the fault indicator (yellow) lights up or blinks, refer to "**Chapter 5 Troubleshooting**" and report the symptoms to the maintenance in charge.

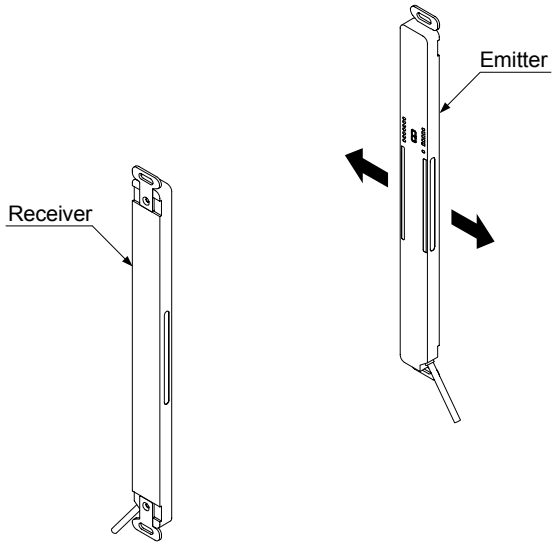
3. Loosen the hexagon-socket head bolts [M5 (please arrange separately)] which holds the standard mounting bracket **MS-SFC-1**.

4. Move the emitter in the left and right directions in order to determine the range of the light received condition with the help of the beam-axis alignment indicator (red). Then, set the emitter at the center of this range.

5. Similar to the step 4, perform the beam-axis alignment for the receiver.

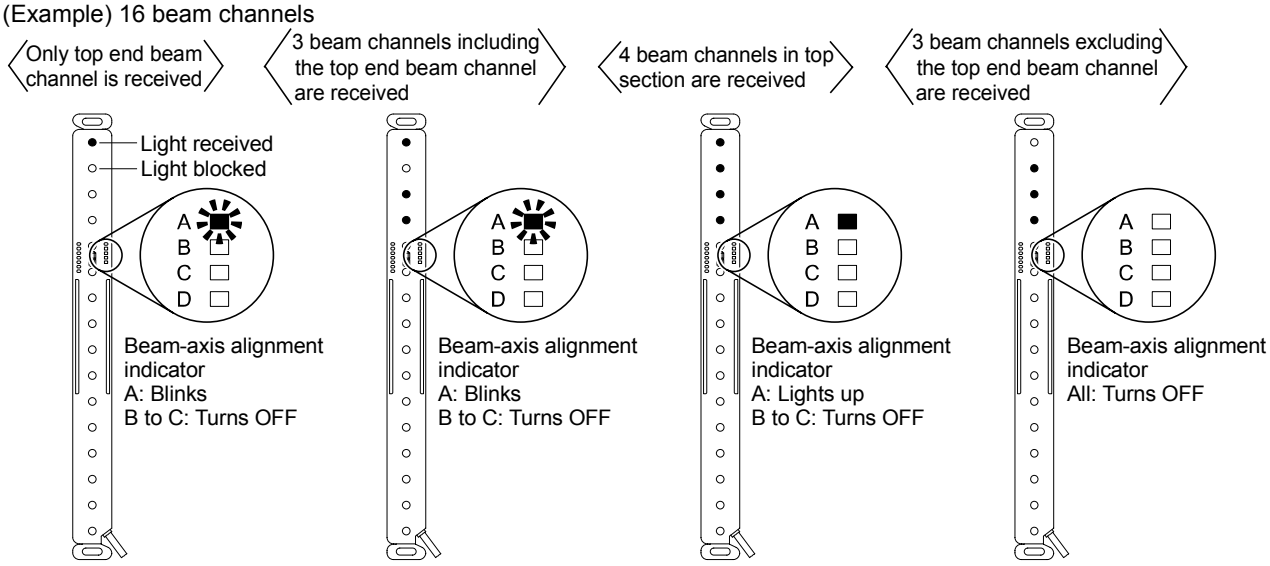
6. Tighten the standard mounting bracket **MS-SFC-1** by the hexagon-socket head bolt [M5 (please arrange separately)].

7. Check, once again, that the beam-axis alignment indicators (red), operation indicator (green) and OSSD indicator (green) in the display of the emitter and receiver do light up.



<Reference>

The beam-axis alignment indicator indicates the reception status for each section of the device which is divided into 4 sections.
Furthermore, the A (D) of the beam-axis alignment indicates the light-receiving status of the device top end (bottom end).
For example, when using a 16-beam channel device, there are 4 beam channels per section (i.e., 16/4=4).
When the top end (bottom end) beam channel is received, the A (D) of the beam-axis alignment indicator blinks in red.
(Example) 16 beam channels



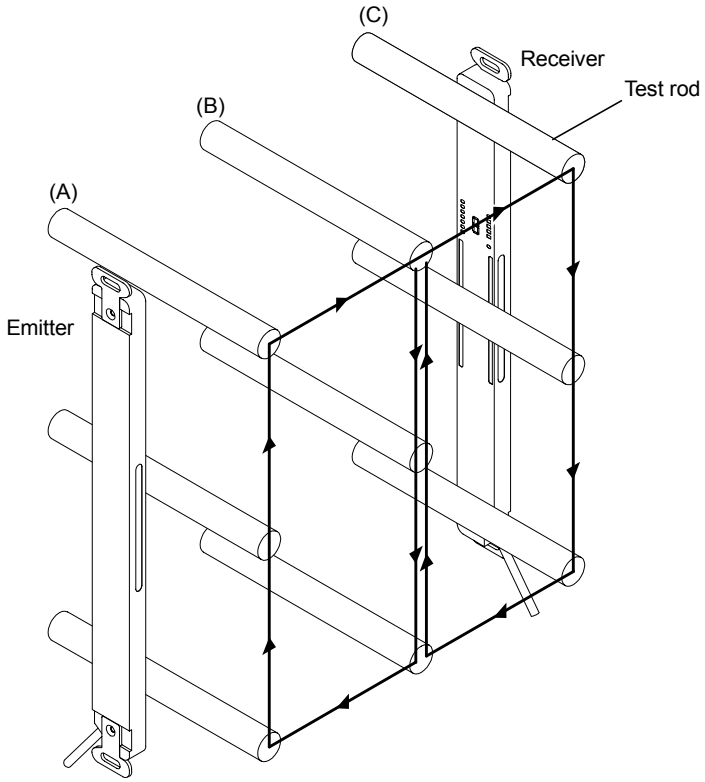
When all the 4 beam channels divided into each section are received, the beam-axis alignment indicator lights up in red. The indicators corresponding to the different sections light up in red, one by one, when the beam channels of the respective sections are received. When all the beam channels are received and the control output (OSSD 1 / 2) turns ON, all the four indicators of the beam-axis alignment indicator turn into green.
Refer to "**2-6-2 Operation Test**" for details.

2-6-2 Operation Test

1.Turn ON the power supply unit of this device.

2. Check that the digital error indicator (red) and the fault indicator (yellow) of the emitter and the receiver are OFF respectively.
   - If the digital error indicator (red) or the fault indicator (yellow) lights up or blinks, refer to "**Chapter 5 Troubleshooting**" and report the symptoms to the maintenance in charge.

3. Move the test rod up and down 1,600 mm/sec. or less at three positions, just in front of the emitter (A), between the emitter and receiver (B) and just in front of the receiver (C).



4. During Step 3 above, check that the control output (OSSD 1 / 2) is in OFF state, and both the OSSD indicator (red) of the receiver and the operation indicator (red) of the emitter light up as long as the test rod is present within the sensing area.
   - If the behavior of the control output (OSSD 1 / 2) and the turning ON / OFF of the emitter / receiver indicators do not correspond to the movement of the test rod, refer to "**Chapter 5 Troubleshooting**" and report the symptoms to the maintenance in charge.

<Reference>

If the indicators show reception of the light even though the test rod blocks the light, check whether there is any reflective object or extraneous light source near this device or not.

2-6-3 Operation

1) Normal Operation

The status of the emitter / receiver indicators during normal operation is as described below.

: Blinks in red : Lights up in red : Lights up in orange : Lights up in green : Turns OFF

State of this device		Indicators		Control output	
		Emitter	Receiver	OSSD 1	OSSD 2
Light received status (All beams received)		FAULT, PNP (Note 1), NPN, TEST, S1, S2, (Note 2); STB, A, B, C, D, RECEPTION, OSSD	FAULT, PNP (Note 1), NPN, FUNCTION, INTERLOCK, MU1, MU2; STB, A, B, C, D, RECEPTION, OSSD	ON	
Light blocked status	One or more beams blocked	FAULT, PNP (Note 1), NPN, TEST, S1, S2, (Note 2); STB, A, B, C, D, RECEPTION, OSSD	FAULT, PNP (Note 1), NPN, FUNCTION, INTERLOCK, MU1, MU2; STB, A, B, C, D, RECEPTION, OSSD	OFF	
	Lights other than the top end blocked	FAULT, PNP (Note 1), NPN, TEST, S1, S2, (Note 2); STB, A, B, C, D, RECEPTION, OSSD	FAULT, PNP (Note 1), NPN, FUNCTION, INTERLOCK, MU1, MU2; STB, A, B, C, D, RECEPTION, OSSD	OFF	
	Lights other than the bottom end blocked	FAULT, PNP (Note 1), NPN, TEST, S1, S2, (Note 2); STB, A, B, C, D, RECEPTION, OSSD	FAULT, PNP (Note 1), NPN, FUNCTION, INTERLOCK, MU1, MU2; STB, A, B, C, D, RECEPTION, OSSD	OFF	
Timing chart		Power supply: ON / OFF; 2 sec. or less; Light received status: Light received / Light blocked; 90ms or less; 7ms or less; 90ms or less; Control output (OSSD 1 / 2): ON / OFF			

Notes: 1) The status of the emitter / receiver indicators during operation above shows the case in PNP output setting mode. In case of NPN output setting mode, the NPN indicator (orange) lights up.
2) Since the color of the operation indicator changes according to the ON / OFF state of the control output (OSSD 1 / 2), the operation indicator is marked as OSSD on the device.

2) When using test input function

This device incorporates the test input function. Using this function, it is possible to simulate the light blocked status.

<Reference>

When the test input / reset input is kept open (for manual reset of PNP output: connect to +V, for manual reset of NPN output: connect to 0V), the test input function will be valid and the receiver will be OFF with the emitting light is received.

● : Lights up in red ◐ : Lights up in orange ◑ : Lights up in green ○ : Turns OFF

Setting procedure and check items		Indicators		Control output	
		Emitter	Receiver	OSSD 1	OSSD 2
1	Before power is ON Connect the test input / reset input to Vs (Note 1)	FAULT ○ PNP ○ NPN ○ TEST ○ S1 ○ S2 ○ (Note 3) ○ OSSD ○ STB □ A □ B □ C □ D RECEPTION	FAULT ○ PNP ○ NPN ○ FUNCTION ○ INTERLOCK ○ MU1 ○ MU2 ○ ○ OSSD ○ STB □ A □ B □ C □ D RECEPTION	OFF	
2	After power is ON Receiver's control output (OSSD 1 / 2) is ON (Normal operation)	FAULT ○ PNP ◐ (Note 2) NPN ○ TEST ○ S1 ◐ S2 ◐ (Note 3) ◑ OSSD ◑ STB ◑ A ◑ B ◑ C ◑ D RECEPTION	FAULT ○ PNP ◐ (Note 2) NPN ○ FUNCTION ○ INTERLOCK ○ MU1 ○ MU2 ○ ◑ OSSD ◑ STB ◑ A ◑ B ◑ C ◑ D RECEPTION	ON	
3	Open the test input / reset input Receiver's control output (OSSD 1 / 2) is OFF (Test input valid) (Normal operation)	FAULT ○ PNP ◐ (Note 2) NPN ○ TEST ◐ S1 ◐ S2 ◐ (Note 3) ● OSSD ○ STB ■ A ■ B ■ C ■ D RECEPTION	FAULT ○ PNP ◐ (Note 2) NPN ○ FUNCTION ○ INTERLOCK ○ MU1 ○ MU2 ○ ● OSSD ○ STB ■ A ■ B ■ C ■ D RECEPTION	OFF	
4	Connect the test input / reset input to Vs (Note 1) Receiver's control output (OSSD 1 / 2) is ON (Normal operation)	FAULT ○ PNP ◐ (Note 2) NPN ○ TEST ○ S1 ◐ S2 ◐ (Note 3) ◑ OSSD ◑ STB ◑ A ◑ B ◑ C ◑ D RECEPTION	FAULT ○ PNP ◐ (Note 2) NPN ○ FUNCTION ○ INTERLOCK ○ MU1 ○ MU2 ○ ◑ OSSD ◑ STB ◑ A ◑ B ◑ C ◑ D RECEPTION	ON	

Notes: 1) Vs is the applying supply voltage.
2) The status of the emitter / receiver indicators during operation above shows the case in PNP output setting mode. In case of NPN output setting mode, the NPN indicator (orange) lights up.
3) Since the color of the operation indicator changes according to the ON / OFF state of the control output (OSSD 1 / 2), the operation indicator is marked as OSSD on the device.

3) When an error occurs

If a device error is detected, the device will turn the control output (OSSD 1 / 2) OFF. Then the digital error indicator (red) on the receiver lights up and the fault indicators (yellow) on the emitter and receiver light up or blink.

- If an emitter error is detected, the emitter will be locked out, stopping its emission, and the control output (OSSD 1 / 2) will be turned OFF.
- If a receiver error is detected, the receiver will be locked out, and the control output (OSSD 1 / 2) will go into OFF state. Also, the test input indicator (orange) of the emitter lights up.

: Blinks in yellow : Lights up in orange : Lights up in green : Turns OFF

State of this device	Indicators		Control output	
	Emitter	Receiver	OSSD 1	OSSD 2
Normal state	FAULT ○ PNP ● (Note 1) NPN ○ TEST ○ S1 ● S2 ● (Note 2) STB ● A ■ B ■ C ■ D ■ RECEPTION OSSD ●	FAULT ○ PNP ● (Note 1) NPN ○ FUNCTION ○ INTERLOCK ○ MU1 ○ MU2 ○ STB ● A ■ B ■ C ■ D ■ RECEPTION OSSD ●	ON	
Error state	FAULT ◉ PNP ● (Note 1) NPN ○ TEST ○ S1 ○ S2 ○ (Note 2) 8 STB ○ A □ B □ C □ D □ RECEPTION OSSD ○	FAULT ◉ PNP ● (Note 1) NPN ○ FUNCTION ○ INTERLOCK ○ MU1 ○ MU2 ○ 8 STB ○ A □ B □ C □ D □ RECEPTION OSSD ○	OFF	

Notes: 1) The status of the emitter / receiver indicators during operation above shows the case in PNP output setting mode. In case of NPN output setting mode, the NPN indicator (orange) lights up.
2) Since the color of the operation indicator changes according to the ON / OFF state of the control output (OSSD 1 / 2), the operation indicator is marked as OSSD on the device.
3) Refer to "**Chapter 5 Troubleshooting**" for details of the digital error indicator.

Since this device will not return to normal operation automatically after the removal of the source of error, it is necessary to turn the power OFF and ON again.

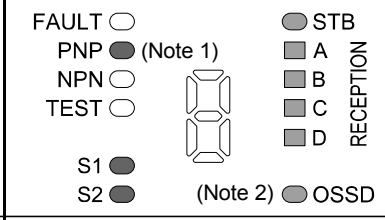
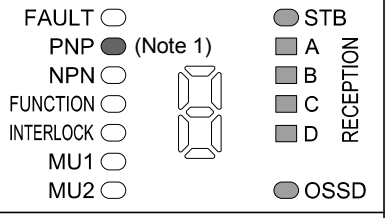
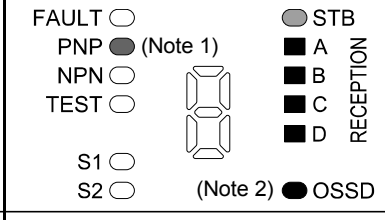
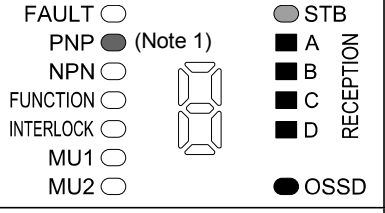
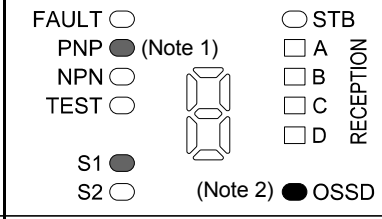
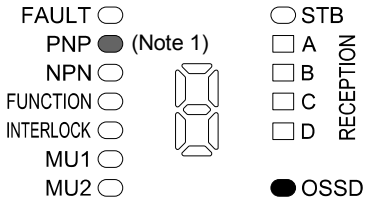
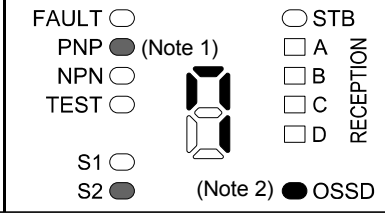
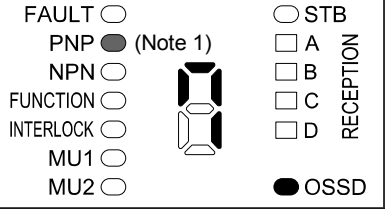
(Source of error): The control output (OSSD 1 / 2) short-circuit, extraneous light detection, sensor failure, etc.

Refer to "**Chapter 5 Troubleshooting**" and remove the source of error.

4) When using safety input function

This device incorporates the safety input function. This function controls the control output (OSSD 1 / 2) of this device by receiving detection signal of a safety contacting point which is connected to the safety input 1 or 2.

● : Lights up in red ◐ : Lights up in orange ◐ : Lights up in green ○ : Turns OFF

Setting procedures and check items	Indicators		Control output	
	Emitter	Receiver	OSSD 1	OSSD 2
Safety input ON			ON	
Safety input OFF			OFF	
Safety input error (Safety input 1: Connected Safety input 2: Not connected)			OFF	
Safety input error (Safety input 1: Not connected Safety input 2: Connected)			OFF	

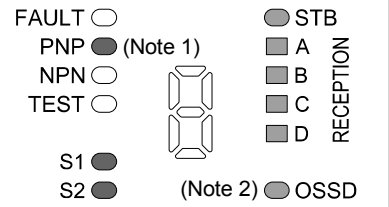
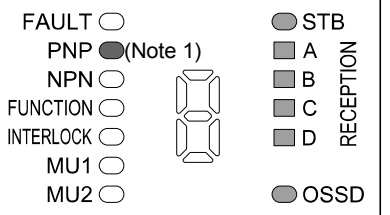
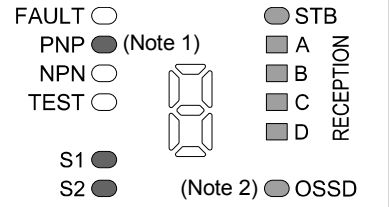
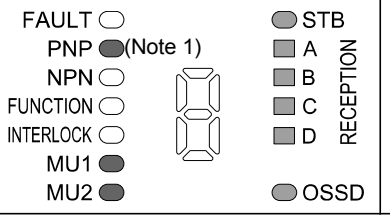
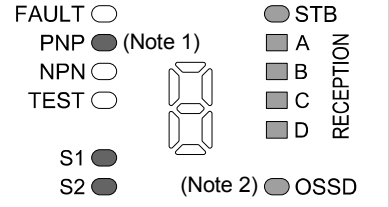
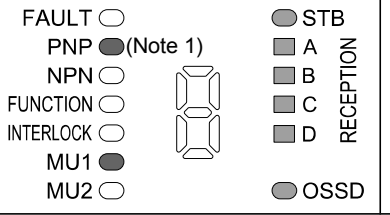
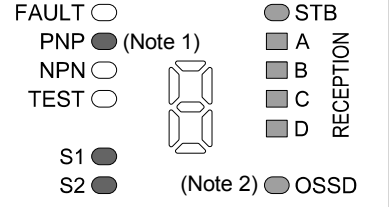
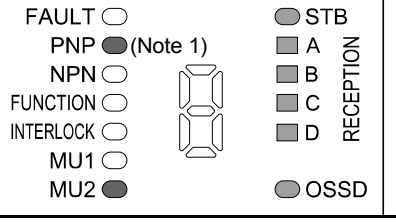
Notes: 1) The status of the emitter / receiver indicators during operation above shows the case in PNP output setting mode. In case of NPN output setting mode, the NPN indicator (orange) lights up.

2) Since the color of the operation indicator changes according to the ON / OFF state of the control output (OSSD 1 / 2), the operation indicator is marked as OSSD on the device.

5) When using muting input function

This function turns the safety function into invalid temporarily. When the control output (OSSD 1 / 2) is ON, this function is available for passing the sensing object through the sensing area of the device without stopping the device.

● : Lights up in orange ● : Lights up in green ○ : Turns OFF

Setting procedures and check items	Indicators		Control output	
	Emitter	Receiver	OSSD 1	OSSD 2
Muting sensor is OFF			ON	
Muting sensor is ON (Muting input 1: ON, Muting input 2: ON)			ON	
Muting sensor is ON (Muting input 1: ON, Muting input 2: OFF)			ON	
Muting sensor is ON (Muting input 1: OFF, Muting input 2: ON)			ON	

Notes: 1) The status of the emitter / receiver indicators during operation above shows the case in PNP output setting mode. In case of NPN output setting mode, the NPN indicator (orange) lights up.

2) Since the color of the operation indicator changes according to the ON / OFF state of the control output (OSSD 1 / 2), the operation indicator is marked as OSSD on the device.

3-1 Self-diagnosis Function

This device incorporates the self-diagnosis function.
The self-diagnosis is carried out when the power is turned ON and while the operation periodically.
In case an abnormality is detected during self-diagnosis, the device is put in the lockout state at that instant, and the control output (OSSD 1 / 2) is fixed at the OFF state. Refer to "**Chapter 5 Troubleshooting**" and remove the source of error.

3-2 Interlock Function

The selection of manual reset / auto reset is available by applying the interlock setting input wire (pale purple).
The interlock becomes available by selecting manual reset.

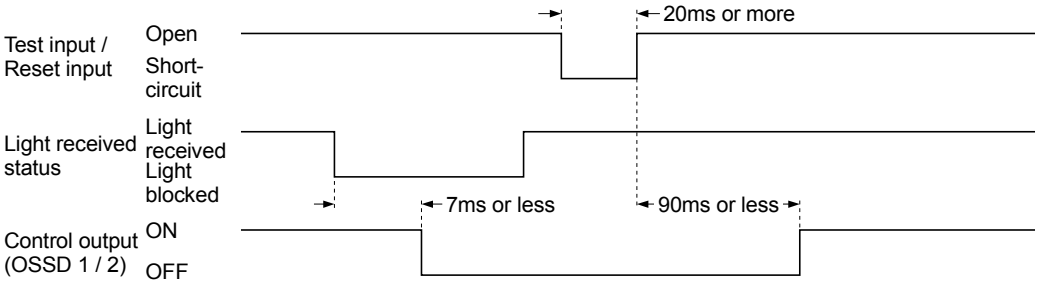
Interlock setting input wire (pale purple)	Setting for interlock function
Connect to +V for PNP output Connect to 0V for NPN output	Manual reset
Open	Auto reset

⚠ WARNING Make sure that there exist no operator in the dangerous zone when using the interlock function, which can result in death or serious injury.

3-2-1 Manual Reset

The control output (OSSD 1 / 2) is not turned ON automatically even though this device is received the light.
When this device is reset in light received state [open the test input / reset input → short-circuit the device to +V for PNP output or +0 for NPN output → open], the control output (OSSD 1 / 2) is turned ON.

<Timing chart>

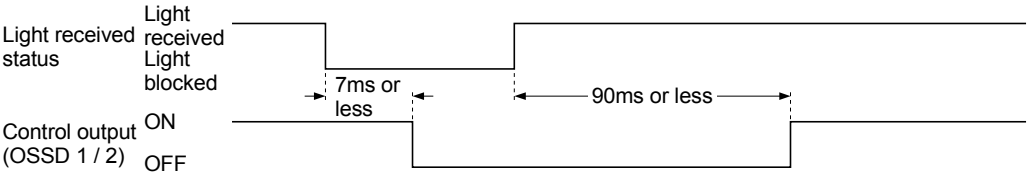


⚠ WARNING The reset switch shall be placed in area where all over the dangerous zone shall be comprehend and out side of the dangerous zone.

3-2-2 Auto Reset

The control output (OSSD 1 / 2) is turned ON automatically when this device receives the light.

<Timing chart>



⚠ WARNING If this device is used with the auto reset, avoid an auto restart after the safety output stop of the system by using a safety relay unit, etc. (EN 60204-1)

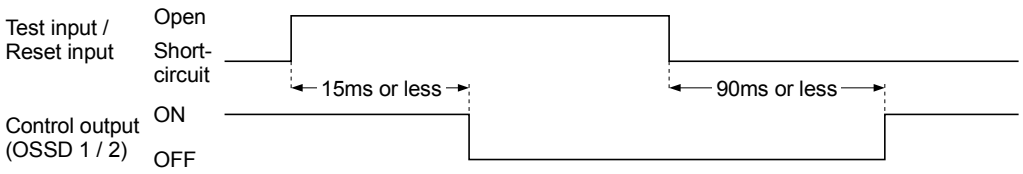
3-3 Test Input Function

This function enables checking of the device operation by forcibly turning ON / OFF the control output (OSSD 1 / 2) of the receiver with the emitting light is received.
The selection of output ON / OFF is available by applying the test input / reset input wire (pink).

Interlock function	Test input / Reset input wire (pink)	Test input	Output status
Manual reset	Open	Invalid	ON
	Connect to +V for PNP output Connect to 0V for NPN output	Valid	OFF
Auto reset	Open	Valid	OFF
	Connect to +V for PNP output Connect to 0V for NPN output	Invalid	ON

When the test input is valid, the control output (OSSD 1 / 2) becomes OFF.
By using this function, malfunction due to extraneous noise or abnormality in the control output (OSSD 1 / 2) and the auxiliary output can be determined even from the equipment side.
In case of PNP output, normal operation is restored when the test input / reset input wire (pink) is connected to +V (for manual reset: open).
In case of NPN output, normal operation is restored when the test input / reset input wire (pink) is connected to 0V (for manual reset: open).

<Timing chart>



⚠ WARNING

Do not use the test input function for the purpose of stopping the machine in which the **SF4C** series is installed. Failure to do so could result in death or serious injury.

3-4 Safety Input Function

This function controls the control output (OSSD 1 / 2) of this device by receiving detection signal of a safety contacting point which is connected to the safety input 1 wire (gray) and the safety input 2 wire (gray / black). The control output (OSSD 1 / 2) forcibly turning OFF when when safety input 1 / 2 is OFF.
The safety contacting points are available for an emergency stop switch with two NC (Normally Closed) contacting points, etc.**<Output operations of a safety contacting point and a safety sensor>**

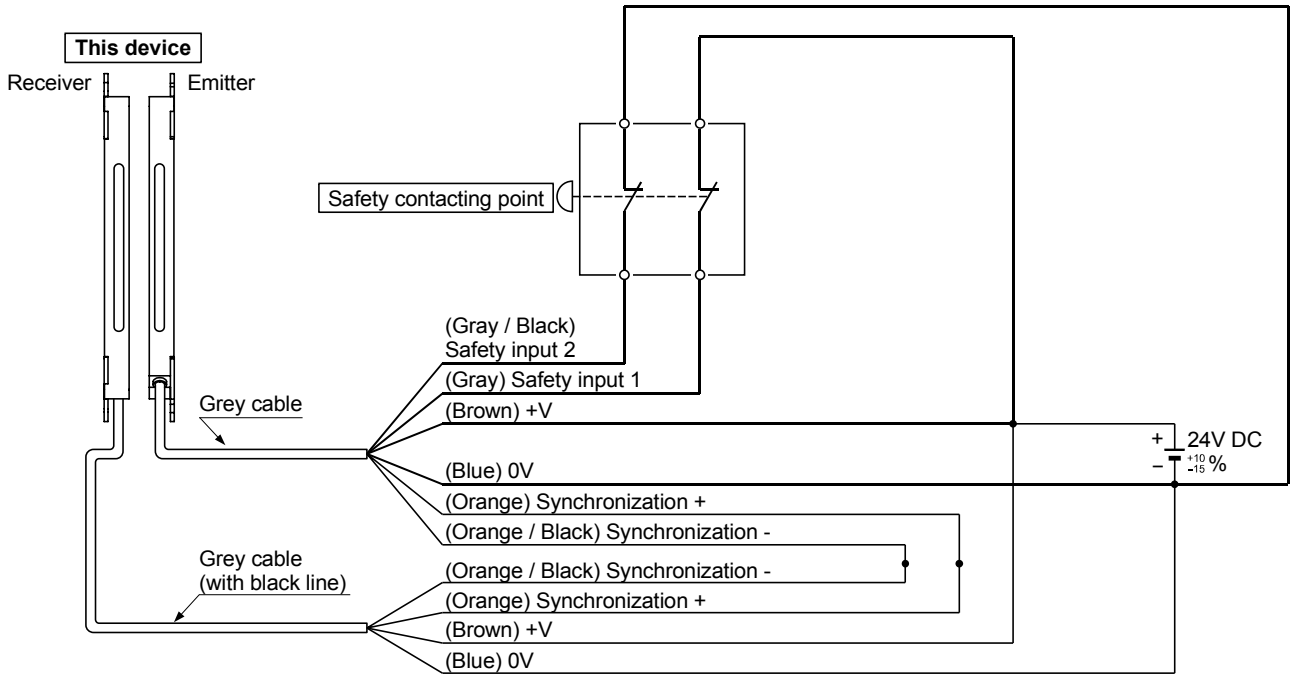
	NC (Normally Closed) type	Operation at ON state	Operation at OFF state
Safety contacting point	ON with object non-contacted status (Emergency stop switch, etc.)	PNP output: Connect to +V NPN output: Connect to 0V	Open

⚠ CAUTION

- Use a safety contacting point which incorporates two NC (Normally Closed) contacting points and connect both the safety input 1 wire (gray) and the safety input 2 wire (gray / black). Take care that if only one wire is connected, the device may not operate normally.
- Make sure to connect to +V or 0V when not using safety input function.

Safety input function	For PNP output		For NPN output	
	Safety input 1 wire (gray)	Safety input 2 wire (gray / black)	Safety input 1 wire (gray)	Safety input 2 wire (gray / black)
Safety contacting point input mode	Connect to +V	Connect to 0V	Connect to +V	Connect to 0V

<Wiring example for safety contacting point>
Connect the emitter of this device and the safety contacting point as follows.
In case of using lead wires other than those described below, perform wiring depending on your application. For details, refer to "**2-5 Wiring**."



- Safety input
  Short-circuit (sink current 5 to 10mA, source current 5 to 10mA): Valid, Open: Invalid

3-5 Large Multi-purpose Indicator Function

The selection of lights up / turns OFF is available by applying the large multi-purpose indicator input 1 (gray) or the large multi-purpose indicator input 2 (gray / black).

Large multi-purpose indicator input		Operation of the large multi-purpose indicator
Large multi-purpose indicator input 1 (gray)	PNP output: Connect to +V NPN output: Connect to 0V	Lights up in red
	Open	Turns OFF
Large multi-purpose indicator input 2 (gray / black)	PNP output: Connect to +V NPN output: Connect to 0V	Lights up in green
	Open	Turns OFF

By wiring the large multi-purpose indicator input 1 (gray) and the large multi-purpose indicator input 2 (gray / black) to the auxiliary output wire (yellow-green / black) or the muting lamp output wire (red) (Note), the outputs operate simultaneously with the outputs.

Large multi-purpose indicator input		Operation of the large multi-purpose indicator
Large multi-purpose indicator input 1 (gray)	Auxiliary output wire (yellow-green / black)	Lights up in red when the auxiliary output is ON Turns OFF when the auxiliary output is OFF
	Muting lamp output wire (red) (Note)	Lights up in red when the muting output is ON Turns OFF when the auxiliary output is OFF
	Open	Turns OFF
Large multi-purpose indicator input 2 (gray / black)	Auxiliary output wire (yellow-green / black)	Lights up in green when the auxiliary output is ON Turns OFF when the auxiliary output is OFF
	Muting lamp output wire (red) (Note)	Lights up in green when the muting output is ON Turns OFF when the auxiliary output is OFF
	Open	Turns OFF

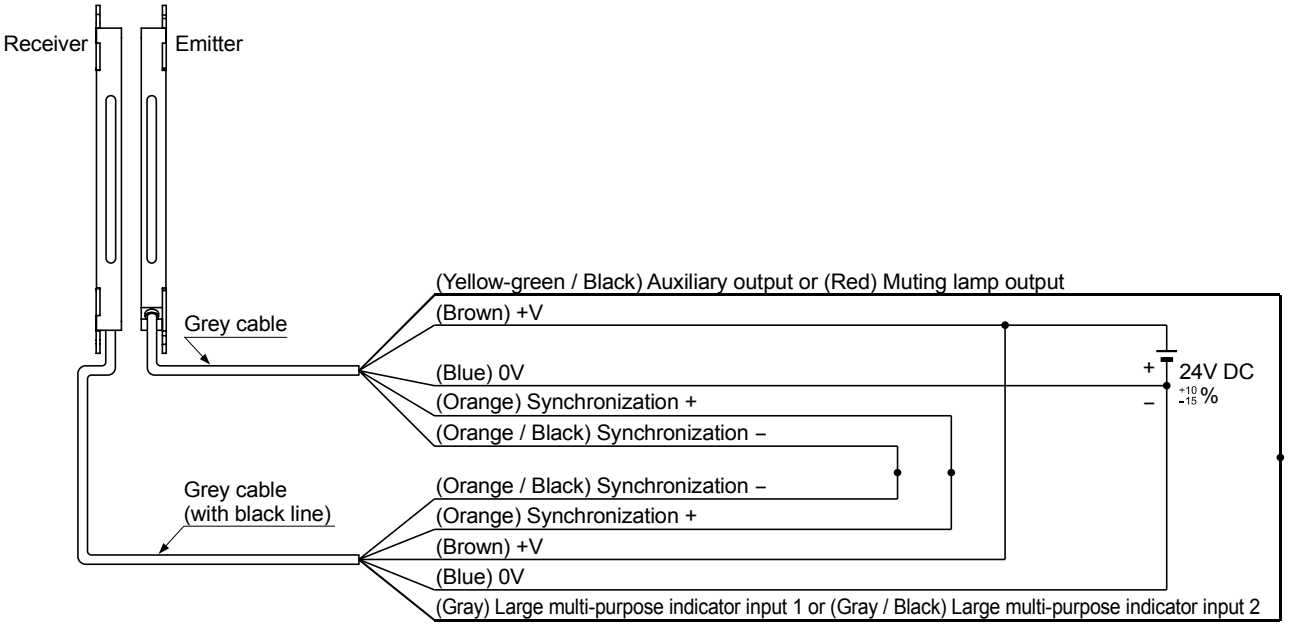
Note: Using PNP output, if wiring the large multi-purpose indicator input 1 wire (gray) and the large multi-purpose indicator input 2 wire (gray / black) to muting lamp output wire (red), the large multi-purpose indicator does not operate.

<Wiring example of the large multi-purpose indicator input 1 / 2 (common to PNP / NPN output)>

Wire the large multi-purpose indicator input 1 wire (gray) or the large multi-purpose indicator input 2 wire (gray / black) as follows.

As for lead wires other than below, perform wiring depending on your application.

For details, refer to "**2-5 Wiring**."

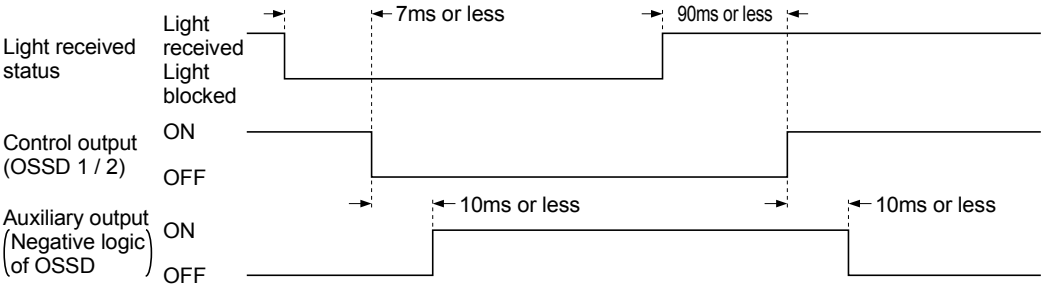


3-6 Auxiliary Output (Non-safety Output)

This device incorporates the auxiliary output for the non-safety output.
The auxiliary output is incorporated in the emitter.

Auxiliary output setting	Normal mode			Lockout
	Test input valid	Negative logic of the control output (OSSD 1 / 2)		
		Light received	Light blocked	
Negative logic of the control output (OSSD 1 / 2)	ON	OFF	ON	ON

<Timing chart>



⚠ WARNING

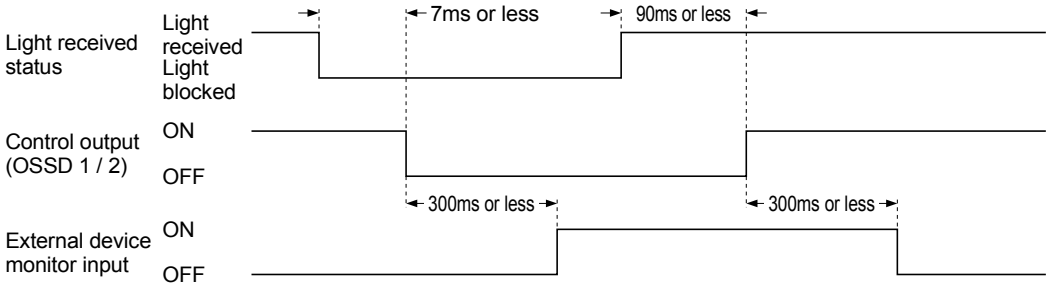
Do not use the auxiliary output for the purpose of stopping the machine in which the **SF4C** series is installed. Failure to do so could result in death or serious injury.

3-7 External Device Monitor Function

This is the function for checking whether the external safety relay connected to the control output (OSSD 1 / 2) performs normally in accordance with the control output (OSSD 1 / 2) or not. Monitor the contacting point “b” of the external safety relay, and if any abnormality such as deposit of the contacting point, etc. is detected, change the status of the device into lockout one, and turn OFF the control output (OSSD 1 / 2).

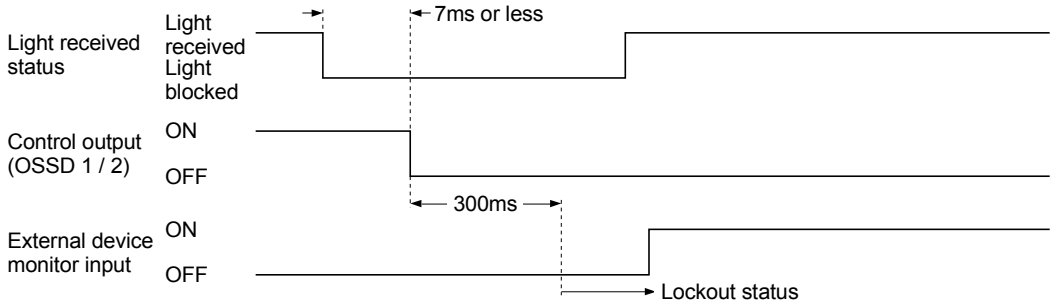
- **When the external device monitor function is set to be valid:**
  Connect the external device monitor input wire (yellow-green) to the external safety relay which is connected to the control output 1 (OSSD 1) wire (black) and the control output 2 (OSSD 2) wire (white).
- **When the external device monitor function is set to be invalid:**
  Connect the external device monitor input wire (yellow-green) to the auxiliary output wire (yellow-green / black). The auxiliary output cannot be connected to external devices.

<Timing chart (normal)>

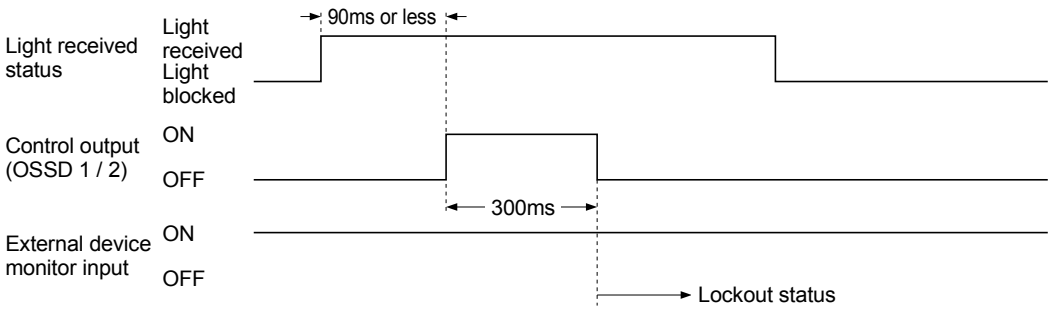


The setting time of the device monitor is 300ms or less. Exceeding 300ms turns the device into lockout status.

<Timing chart (Error 1)>



<Timing chart (Error 2)>



3-8 Muting Function

⚠ WARNING

- Incorrect using of the muting control may cause any accident. Please understand the muting control fully, and use it. As for the muting control, the following international standards define the requirements.
  ISO 13849-1 (JIS B 9705-1):
  "Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design, Article 5.2.5 Muting"
  IEC 61496-1 (UL 61496 / JIS B 9704-1):
  "Safety of machinery - Electro sensitive protective equipment - Part 1: General requirements and tests, Annex A, A.7 Muting"
  IEC 60204-1 (JIS B 9960-1):
  "Safety of machinery - Electrical equipment of machines - Part 1: General requirements, 9.2.4 Overriding safeguards"
  IEC / TS 62046:
  "Safety of machinery - Application of protective equipment to detect the presence of persons"
  EN 415-4:
  "Safety of packaging machines - Part 4: Palletizers and depalletizers, Annex A, A2.2 Muting"
  ANSI B11.19-1990:
  "for Machine Tools-Safeguarding When Referenced by the Other B11 Machine Tool Safety Standards-Performance Criteria for the Design, Construction, Care, and Operation" 4.2.3 Presence-Sensing Devices: Electro-Optical and Radio Frequency (R.F.)
  ANSI/RIA R15.06-1999:
  "for Industrial Robots and Robot Systems - Safety Requirements, 10.4.5 Muting"
- Use the muting control while the machine cycle is not in danger mode. Maintain safety with the other measure while the muting control is activating.
- For the application that the muting control is activated when a sensing object passes through the sensor, place the muting sensor so that the conditions for the muting control cannot be satisfied by intrusion of personnel when the sensing object is passing through the sensor or the sensing object is not passing through it.
- The muting lamp should be installed in a position where it can always be seen by operators who set or adjust the machine.
- Be sure to check the operation of the muting function before its use. Furthermore, check the state of the muting lamp (cleanliness or brightness etc.)

This function turns the safety function into invalid temporarily. When the control output (OSSD 1 / 2) is ON, this function is available for passing the sensing object through the sensing area of the device without stopping the device.

The muting function becomes valid when all the conditions listed below are satisfied:

- The control output (OSSD 1 / 2) shall be ON.
- The safety output 1 / 2 shall be ON.
- Time difference between the time during muting input 1 / 2 becomes ON from OFF (open) and the time during muting input 1 / 2 becomes OFF (open) from ON should be between 0.03 to 3 sec.

The following devices, photoelectric sensor with semiconductor output, inductive proximity sensor, position switch on NO (Normally Open) contacting point, etc. are available for applying to the muting sensor.

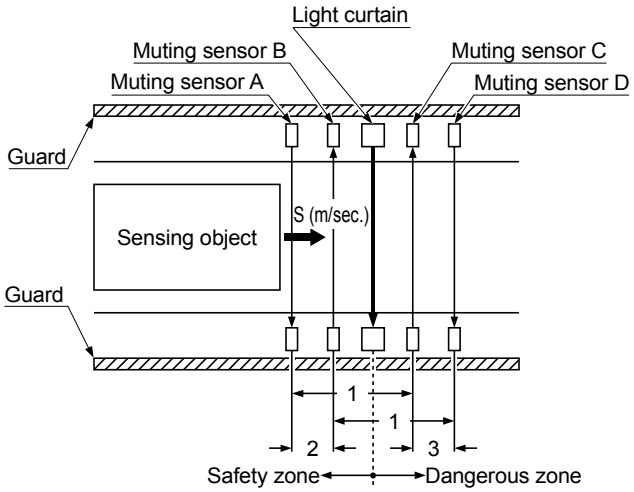
<Output operation of muting sensors>

	Operation with ON state	Operation with OFF state
NO (Normally Open) type ON with dark status (photoelectric sensor, etc.) ON with object approaching status (inductive proximity sensor, etc.) ON with object contacted status (position switch, etc.)	0V or +V	Open

⚠ WARNING

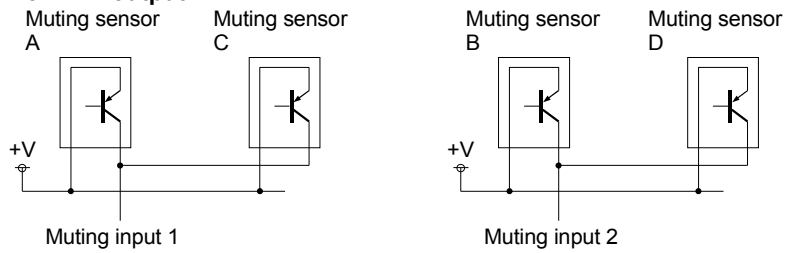
Be sure to use a muting sensor that satisfies the **<Output operation of muting sensor>** above. If the other muting sensor not satisfying the specification above, the muting function might become valid with the timing that the machine designer cannot expect and could result in death or serious injury.

<Installation condition example of muting sensors>

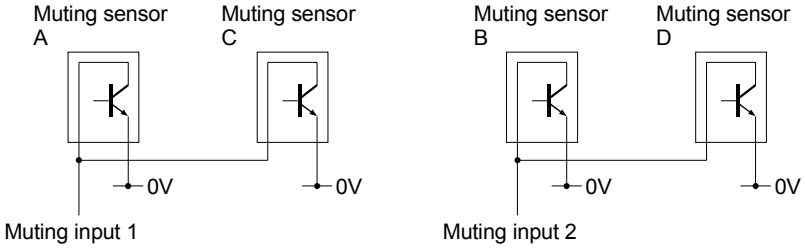


1. Shorten the distances between muting sensors A to C and between B to D than the whole length of the sensing object.
2. The time of the sensing object to be passed through the muting sensors A to B shall be 0.03 to under 3 sec.
   Distance between A and B (m) < S (m/sec.) × 3 (sec.)
   S: The moving speed (m/sec.) of the sensing object
3. The time of the sensing object to be passed through the muting sensors C to D shall be under 3 sec.
   Distance between C and D (m) < S (m/sec.) × 3 (sec.)
   S: The moving speed (m/sec.) of the sensing object

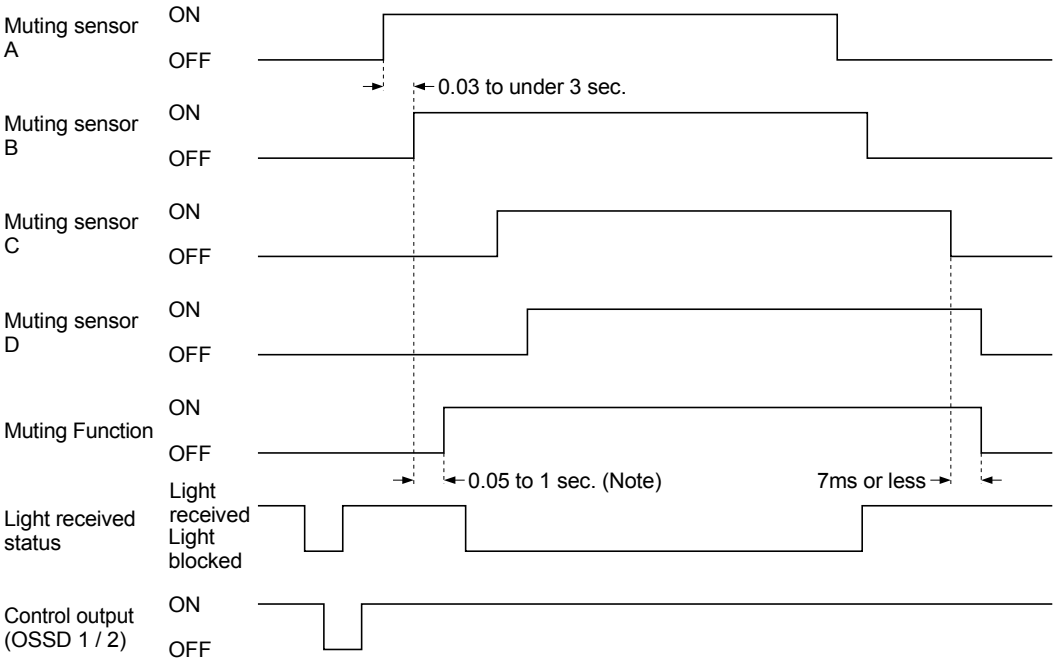
<For PNP output>



<For NPN output>



<Timing chart>



Note: If the muting lamp does not light up even if 1sec. or more when the muting lamp diagnosis function is valid, the muting function becomes invalid. When the muting lamp diagnosis function is invalid, the muting function becomes valid after 0.05 sec. from the input conditions of the muting sensor A (C) and B (D) were satisfied.

<Reference>

It is recommended that two muting lamps should be connected in parallel. In this case, take care not to exceed total 6W or less.

3-9 Override Function

⚠ WARNING

- Incorrect using of the muting control may cause any accident. Please understand the muting control fully, and use it. As for the muting control, the following international standards define the requirements.
  ISO 13849-1 (JIS B 9705-1):
  "Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design, Article 5.9 Muting"
  IEC 61496-1 (UL 61496 / JIS B 9704-1):
  "Safety of machinery - Electro sensitive protective equipment - Part 1: General requirements and tests, Annex A, A.7 Muting"
  IEC 60204-1 (JIS B 9960-1):
  "Safety of machinery - Electrical equipment of machines - Part 1: General requirements, 9.2.4 Overriding safeguards"
  IEC / TS 62046:
  "Safety of machinery - Application of protective equipment to detect the presence of persons"
  EN 415-4:
  "Safety of packaging machines - Part 4: Palletizers and depalletizers, Annex A, A2.2 Muting"
  ANSI B11.19-1990:
  "for Machine Tools-Safeguarding When Referenced by the Other B11 Machine Tool Safety Standards-Performance Criteria for the Design, Construction, Care, and Operation" 4.2.3 Presence-Sensing Devices: Electro-Optical and Radio Frequency (R.F.)
  ANSI/RIA R15.06-1999:
  "for Industrial Robots and Robot Systems - Safety Requirements, 10.4.5 Muting"
- Use the muting control while the machine cycle is not in danger mode. Maintain safety with the other measure while the muting control is activating.
- For the application that the muting control is activated when a sensing object passes through the sensor, place the muting sensor so that the conditions for the muting control cannot be satisfied by intrusion of personnel when the sensing object is passing through the sensor or the sensing object is not passing through it.
- The muting lamp should be installed in a position where it can always be seen by operators who set or adjust the machine.
- Be sure to check the operation of the muting function before its use. Furthermore, check the state of the muting lamp (cleanliness or brightness etc.)

The override function forcibly turns the safety function into invalid. This function is used for the following cases: when the customer who uses the muting function needs to start the device with the control output (OSSD 1 / 2) be OFF status, when the device is required to continue operating even though the muting sensor becomes valid after the muting sensor is turned ON at the starting of line.

The override function becomes valid when all the conditions listed below are satisfied:

- The safety output 1 / 2 shall be ON.
- The signal shall be input to either muting input 1 or 2, or to both of the inputs.
- The override input shall be connected to +V (0V when using NPN output), and the test input / reset input shall be opened (3 sec. continuously).

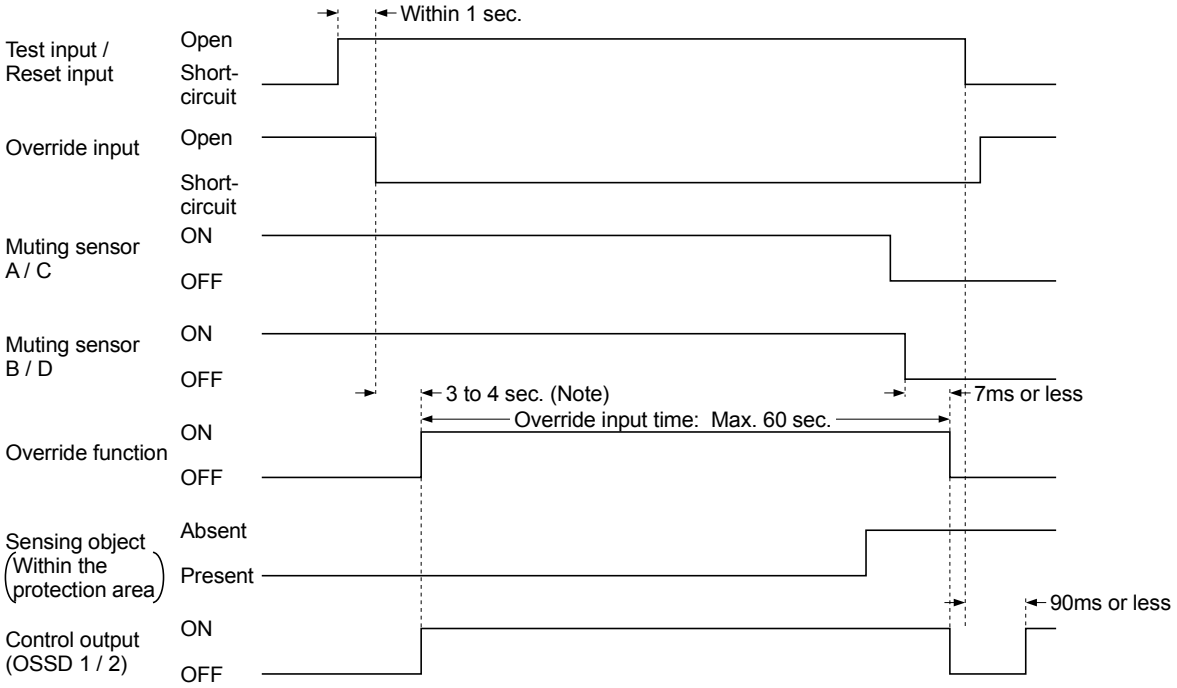
If one of the three conditions above becomes invalid or timing exceeds 60 sec., the override function becomes invalid.

Notes: The override function operates only when the auto reset is ON (the interlock is invalid).

⚠ WARNING

- Make sure manually to operate system for starting override function. Furthermore, the system shall be placed in area where all over the dangerous zone shall be comprehend and out side of the dangerous zone.
- Using override function, make sure that there exist no operator in the dangerous zone, which may result in death or serious injury

<Timing chart>



Note: This is when the muting lamp diagnosis function is valid. If the muting lamp does not light up even if 1 sec. or more is passed, the override function becomes invalid. When the muting lamp diagnosis function is invalid, the muting function becomes valid 3 sec. after the input conditions of the muting sensor A (C) and B (D) were satisfied.

Chapter 4 Maintenance

<Reference>

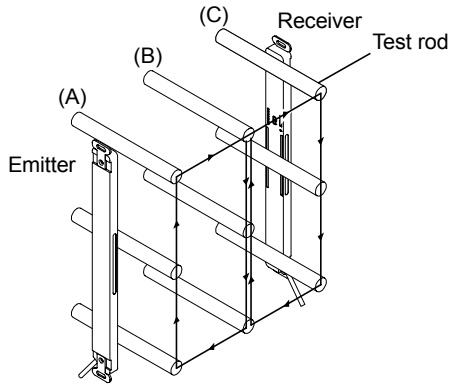
When any errors are found, refer to "**Chapter 5 Troubleshooting**" and report the symptoms to the maintenance in charge.
If the rectification method is not clear, please contact our office.
Please make a copy of this checklist, check each inspection item in the respective square, and file the list for record.

4-1 Daily Inspection

⚠ WARNING

Be sure to inspect the following items prior to operation and confirm that there is no error.
Operating this device without inspection or in an error condition can result in death or serious injury.

Check list (Daily inspection)

Check column	Inspection item
□	Dangerous parts of the machine cannot be reached without passing through the sensing area of this device.
□	Some part of operator's body remains in the sensing area when operation is done with dangerous parts.
□	The calculated safety distance has been maintained or exceeded during installation.
□	There is no damage to the safety guard or protective structure.
□	There is no defect, fold, or damage in the wiring.
□	The corresponding connectors have been connected securely.
□	No dirt or scratches exist on the light emitting surface.
□	The test rod is not deformed or defective.
□	The operation indicator (green) of the emitter and the OSSD indicator (green) of the receiver light up when no object is present in the sensing area. The control output (OSSD 1 / 2) is in ON status. At this time, the effect of external noise can be inspected. In case external noise affects the operation, remove its cause and reinspect.
□	The test rod (ø25 mm) moving 1,600 mm/sec. or less can be detected at three positions, directly in front of the emitter (A), midway between the emitter and the receiver (B), and directly in front of the receiver (C) The OSSD indicator (red) of the receiver and the operation indicator (red) of the emitter continue to light up as long as the test rod is present in the sensing area from (A) to (C). 
□	With the machine in the operating condition, the dangerous parts operate normally when no object is present in the sensing area.
□	With the machine in the operating condition, the dangerous parts stop immediately when the test rod (ø25mm) is inserted into the sensing area at any of the three positions, directly in front of the emitter (A), midway between the emitter and the receiver (B), and directly in front of the receiver (C).
□	The dangerous parts remain stopped as long as the test rod is present in the sensing area.
□	The dangerous parts stop immediately when the power supply of this device is turned OFF.
□	The control output (OSSD 1 / 2) must turn OFF when the test input / reset input wire (pink) is open (for manual reset: connected to 0V or +V). At this time, the effect of external noise can be inspected. In case external noise affects the operation, remove its cause and reinspect.
□	Be sure to check the operation of the muting function before its use. Furthermore, check the state of the muting lamp (cleanliness or brightness etc.)

4-2 Periodic Inspection (Every Six Months)

⚠ WARNING

Be sure to inspect the following items every six months and confirm that there is no error.
Operating this device without inspection or in an error condition can result in death or serious injury.

Check list (Periodic inspection)

Check column	Inspection item
□	The structure of the machine does not obstruct any safety mechanism for stopping operation.
□	No modification has been made in the machine controls which obstructs the safety mechanisms.
□	The output of this device is correctly detected.
□	The wiring from this device is correct.
□	The overall response time of the complete machine is equal or less than the calculated value.
□	The actual number of operation cycle (time) of the limited lifetime parts (relay, etc.) is less than their rated operation cycles (time).
□	No screws or connectors of this device are loose.
□	No extraneous light source or reflective object has been added near this device.

4-3 Inspection after Maintenance

Under the following situations, perform all the inspection items mentioned in "**4-1 Daily Inspection**" and "**4-2 Periodic Inspection (Every Six Months)**."

1) When any parts of this device are replaced.
2) When some abnormality is felt during operation.
3) When beam-axis alignment of the emitter and receiver is done.
4) When the device installation place or environment is changed.
5) When the wiring method or wiring layout is changed.
6) When FSD (Final Switching Device) parts are replaced.
7) When FSD (Final Switching Device) setting is changed.

Chapter 5 Troubleshooting

<Reference>

- Check the wiring.
- Check the power supply voltage and the power supply capacity.

5-1 Troubleshooting of Emitter

<All indicators are OFF>

Cause	Remedy
Power is not being supplied.	Check that the power supply capacity is sufficient. Connect the power supply correctly.
Supply voltage is out of the specified range.	Set the supply voltage correctly.
Connector is not connected securely.	Connect the connector securely.

<Fault indicator (yellow) lights up or blinks>

Cause		Remedy
[Digital error indicator: 0] Setting data error of this device	Noise is out of the specified range.	Check the noise status around this device.
	Internal error	Replace this device.
[Digital error indicator: 3] System error between emitter and receiver	Systems are different between emitter and receiver.	Set the same value to the number of beam channels of emitter and receiver and the output polarity setting wire (shield).
[Digital error indicator: 4] Interlock setting error	Voltage level of interlock setting input wire (pale purple) or test input / reset input wire (pink) is unstable.	Wire the interlock setting input wire (pale purple) and test input / reset input wire (pink) correctly. Refer to "**2-5 Wiring**."
[Digital error indicator: 5] Safety input crossover short-circuit	Safety input 1 wire (grey) or safety input 2 wire (gray / black) is short-circuited.	Wire the safety input 1 wire (grey) or safety input 2 wire (gray / black) correctly. Make sure there is no damage of safety contacting point.
[Digital error indicator: 6] Wiring error of the output polarity setting wire (shield)	Output polarity setting wire (shield) comes down or short-circuits with other I/O wires. Output polarity setting wire (shield) connection of emitter / receiver is incorrect.	Wire the output polarity setting wire (shield) correctly. (0V: PNP output, +V: NPN output) Wire the output polarity setting wire (shield) of the receiver correctly.
[Digital error indicator: 7] Safety input error	Safety input 1 wire (gray) or safety input 2 wire (gray / black) is not correctly wired.	Wire the safety input 1 wire (gray) and the safety input 2 wire (gray / black) correctly. Refer to "**2-5 Wiring**" or "**3-4 Safety Input Function**."
[Digital error indicator: 8] Supply voltage error	Specified voltage is not being supplied.	Check the wiring status, supply voltage, and power supply capacity.
[Digital error indicator: 9] Muting lamp error	Muting lamp output wire (red) short-circuits with 0V or +V.	Wire the muting lamp output wire (red) correctly. Refer to "**2-5 Wiring**." Current value should be within the specified muting lamp output.
	Muting lamp output short-circuits with other I/O wires.	
	Excessive incoming current flows in the muting lamp output.	
	Output polarity setting wire (shield) and muting lamp output wire (red) are not correctly wired.	Wire the output polarity setting wire (shield) correctly. (0V: PNP output, +V: NPN output) Wire the muting lamp output wire (red) to +V. Refer to "**2-5 Wiring**."
	Output circuit error	Output circuit is damaged. Replace this device.
[Digital error indicator: F] Effect from noise or failure of internal circuit	Affected by noise. Internal circuit is broken down.	Check the noise status around this device. Even if the error is not cleared, contact SUNX.
[Digital error indicator: r] Receiver error	Receiver is in lockout state.	Check an error indicator (yellow) of reciever.

<Digital error indicator " E " lights up>

Cause	Remedy
Synchronization + wire (orange) or synchronization – wire (orange / black) error Synchronization + wire (orange) or synchronization – wire (orange / black) is short-circuited or disconnected.	Connect the synchronization + wire (orange) and synchronization – wire (orange / black) properly. Refer to "**2-5 Wiring**."
Receiver error	Check the operation of the receiver side.

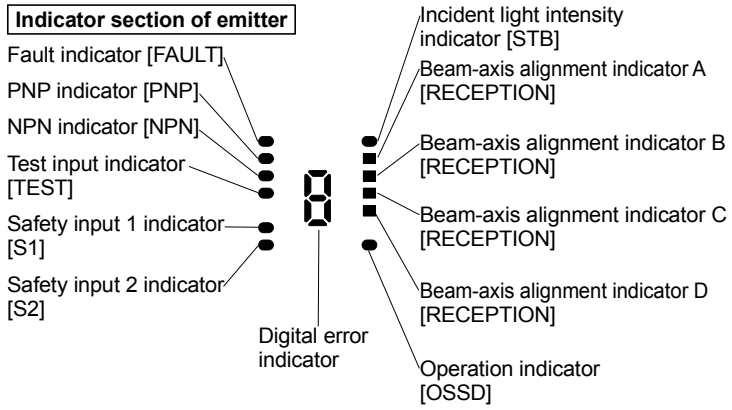
<Test input indicator (orange) lights up>

Cause		Remedy
The device is in the test input condition. (Device error or interlock setting error)	Error indicator (yellow) lights up or blinks.	Check the error contents of the digital error indicator.
	Test input / reset input wire (pink) is open when selecting auto reset.	Wire the test input / reset input wire (pink) to 0V or +V. Refer to "**2-5 Wiring**."
	Test input / reset input wire (pink) is connected to 0V or +V when selecting manual reset.	Open the test input / reset input wire (pink). Refer to "**2-5 Wiring**."

<Operation indicator remains lit in red (light is not received)>

Cause	Remedy
The beam channels are not correctly aligned.	Align the beam channels. Refer to "**2-6 Adjustment**." Align the top / bottom direction of the beam channel between emitter and receiver.

If the device does not work normally after checking the items above, please consult SUNX.


Indicator section of emitter
Fault indicator [FAULT]
PNP indicator [PNP]
NPN indicator [NPN]
Test input indicator [TEST]
Safety input 1 indicator [S1]
Safety input 2 indicator [S2]
Digital error indicator
Incident light intensity indicator [STB]
Beam-axis alignment indicator A [RECEPTION]
Beam-axis alignment indicator B [RECEPTION]
Beam-axis alignment indicator C [RECEPTION]
Beam-axis alignment indicator D [RECEPTION]
Operation indicator [OSSD]

5-2 Troubleshooting of Receiver

<All indicators are OFF>

Cause	Remedy
Power is not being supplied.	Check that the power supply capacity is sufficient. Connect the power supply correctly.
Supply voltage is out of the specified range.	Set the supply voltage correctly.
Connector is not connected securely.	Connect the connector securely.

<Fault indicator (yellow) lights up or blinks>

Cause			Remedy
Digital error indicator: [0] Setting data error of this device	Noise is out of the specified range.		Check the noise status around this device.
	Internal error		Replace this device.
Digital error indicator: [3] System error between emitter and receiver	Systems are different between emitter and receiver.		Set the same value to the number of beam channels of emitter and receiver and the output polarity setting wire (shield).
Digital error indicator: [4] Extraneous light error	Extraneous light is entering or light from other model is entering.		When the power is ON, prevent any extraneous light from entering the receiver. If the extraneous light is coming from other model, conduct "**2-3-4 Device Placement**."
Digital error indicator: [5] Control output (OSSD 1 / 2) data error	Control output 1 (OSSD 1) wire (black) or control output 2 (OSSD 2) wire (white) is short-circuited		Wire the control output 1 (OSSD 1) wire (black) and the control output 2 (OSSD 2) wire (white) correctly. Refer to "**2-5 Wiring**." Current value should be within the specified the control output 1 (OSSD 1) wire (black) and the control output 2 (OSSD 2) wire (white). Refer to "**6-1 Specification**."
	Control output 1 (OSSD 1) wire (black) or control output 2 (OSSD 2) wire (white) is wired or is wired with other I/O wires.		
	Excessive incoming current flows in control output 1 (OSSD 1) wire (black) or control output 2 (OSSD 2) wire (white).		
	Output polarity setting wire (shield), control output 1 (OSSD 1) wire (black) or control output 2 (OSSD 2) wire (white) is not correctly wired.		Wire the output polarity setting wire (shield) correctly. (0V: PNP output, +V: NPN output) Wire the control output 1 (OSSD 1) wire (black) and the control output 2 (OSSD 2) wire (white) correctly. (0V: PNP output, +V: NPN output) Refer to "**2-5 Wiring**."
	Output circuit error		Output circuit is damaged. Replace this device.
Digital error indicator: [6] Wiring error of the output polarity setting wire (shield)	Output polarity setting wire (shield) comes down or short-circuits with other I/O wires. Output polarity setting wire (shield) connection of emitter / receiver is incorrect.		Wire the output polarity setting wire (shield) correctly. (0V: PNP output, +V: NPN output) Wire the output polarity setting wire (shield) of the receiver correctly.
Digital error indicator: [1] External device error	When using safety relay.	Relay contact is welded.	Replace the relay.
		Response time of the relay is slow.	Replace the relay with proper response time. Refer to "**3-6 External Device Monitor Function**."
		Contacting point "b" of the relay is not wired.	Wire correctly to the relay.
	When setting the external device monitor function to "invalid."	Auxiliary output wire (yellow-green / black) and external device monitor input wire (yellow-green) are not wired.	Connect the auxiliary output wire (yellow-green / black) and the external device monitor input wire (yellow-green).
		Auxiliary output is not correctly operated.	Check if the auxiliary output wire (yellow-green / black) is disconnected or short-circuited.
[Digital error indicator: [8] Supply voltage error	Specified voltage is not being supplied.		Check the wiring status, supply voltage and power supply capacity.

Cause		Remedy
[Digital error indicator: E] Emitter error	Emitter is in lockout state.	Check a error indicator (yellow) of emitter.
[Digital error indicator: F] Effect from noise or failure of internal circuit	Affected by noise. Internal circuit is broken down.	Check the noise status around this device. Even if the error is not cleared, contact SUNX.

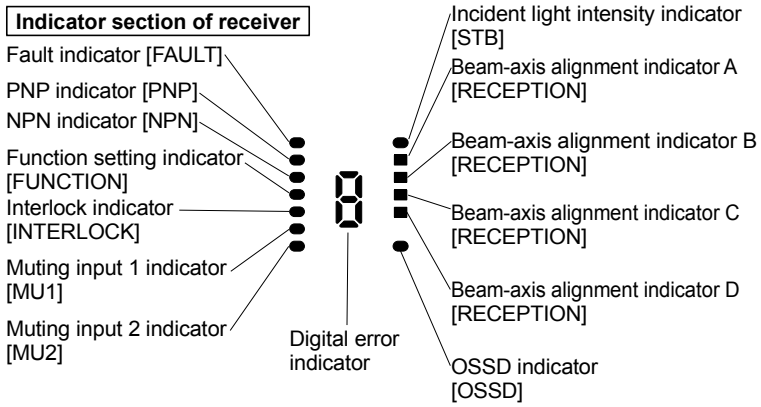
<Digital error indicator " c " lights up>

Cause	Remedy
Synchronization + wire (orange) or synchronization – wire (orange / black) error Synchronization + wire (orange) or synchronization – wire (orange / black) is short-circuited or disconnected.	Connect the synchronization + wire (orange) and synchronization – wire (orange / black) properly. Refer to "**2-5 Wiring**."
Receiver error	Check the operation of the receiver side.

<OSSD indicator remains lit in red (light is not received)>

Cause	Remedy
The beam channels are not correctly aligned.	Align the beam channels. Refer to "**2-6 Adjustment**." Align the top / bottom direction of the beam channel between emitter and receiver.

If the device does not work normally after checking the items above, please consult SUNX.


Indicator section of receiver
Fault indicator [FAULT]
PNP indicator [PNP]
NPN indicator [NPN]
Function setting indicator [FUNCTION]
Interlock indicator [INTERLOCK]
Muting input 1 indicator [MU1]
Muting input 2 indicator [MU2]
Digital error indicator
Incident light intensity indicator [STB]
Beam-axis alignment indicator A [RECEPTION]
Beam-axis alignment indicator B [RECEPTION]
Beam-axis alignment indicator C [RECEPTION]
Beam-axis alignment indicator D [RECEPTION]
OSSD indicator [OSSD]

Chapter 6 Specifications / Dimensions

6-1 Specifications

Model No.

SF4C - H □□ - □

<Cable specifications>
No mark: Cable type, With suffix "J05": Pigtailed type

<Number of beam channels>

Example: **SF4C-H32-J05**
Number of beam channels: 32 channels
Cable specifications: Pigtailed connector type

Model-wise specifications
<Cable type>

Item \ Model No.		SF4C-H8	SF4C-H12	SF4C-H16	SF4C-H20
Number of beam channels		8	12	16	20
Sensing height (Protective height)		160mm	240mm	320mm	400mm
Current consumption	Large multi-purpose indicator OFF	Emitter: 70mA or less Receiver: 85mA or less	Emitter: 70mA or less, Receiver: 90mA or less		Emitter: 70mA or less Receiver: 95mA or less
	Large multi-purpose indicator ON	Emitter: 120mA or less Receiver: 135mA or less	Emitter: 120mA or less, Receiver: 140mA or less		Emitter: 120mA or less Receiver: 145mA or less
PFHd		1.66×10^{-9}	1.90×10^{-9}	2.10×10^{-9}	2.33×10^{-9}
MTTFd		More than 100 years	More than 100 years	More than 100 years	More than 100 years
Weight (total of emitter and receiver)		Approx. 630g	Approx. 700g	Approx. 760g	Approx. 820g

Item \ Model No.		SF4C-H24	SF4C-H28	SF4C-H32
Number of beam channels		24	28	32
Sensing height (Protective height)		480mm	560mm	640mm
Current consumption	Large multi-purpose indicator OFF	Emitter: 70mA or less Receiver: 95mA or less	Emitter: 70mA or less, Receiver: 100mA or less	
	Large multi-purpose indicator ON	Emitter: 120mA or less Receiver: 145mA or less	Emitter: 120mA or less, Receiver: 150mA or less	
PFHd		2.54×10^{-9}	2.77×10^{-9}	2.98×10^{-9}
MTTFd		More than 100 years	More than 100 years	More than 100 years
Weight (total of emitter and receiver)		Approx. 880g	Approx. 950g	Approx. 1,000g

<Pigtailed type>

Item \ Model No.		SF4C-H8-J05	SF4C-H12-J05	SF4C-H16-J05	SF4C-H20-J05
Number of beam channels		8	12	16	20
Sensing height (Protective height)		160mm	240mm	320mm	400mm
Current consumption	Large multi-purpose indicator OFF	Emitter: 70mA or less Receiver: 85mA or less	Emitter: 70mA or less, Receiver: 90mA or less		Emitter: 70mA or less Receiver: 95mA or less
	Large multi-purpose indicator ON	Emitter: 120mA or less Receiver: 135mA or less	Emitter: 120mA or less, Receiver: 140mA or less		Emitter: 120mA or less Receiver: 145mA or less
PFHd		1.66×10^{-9}	1.90×10^{-9}	2.10×10^{-9}	2.33×10^{-9}
MTTFd		More than 100 years	More than 100 years	More than 100 years	More than 100 years
Weight (total of emitter and receiver)		Approx. 240g	Approx. 300g	Approx. 360g	Approx. 420g

Item \ Model No.		SF4C-H24-J05	SF4C-H28-J05	SF4C-H32-J05
Number of beam channels		24	28	32
Sensing height (Protective height)		480mm	560mm	640mm
Current consumption	Large multi-purpose indicator OFF	Emitter: 70mA or less Receiver: 95mA or less	Emitter: 70mA or less, Receiver: 100mA or less	
	Large multi-purpose indicator ON	Emitter: 120mA or less Receiver: 145mA or less	Emitter: 120mA or less, Receiver: 150mA or less	
PFHd		2.54×10^{-9}	2.77×10^{-9}	2.98×10^{-9}
MTTFd		More than 100 years	More than 100 years	More than 100 years
Weight (total of emitter and receiver)		Approx. 490g	Approx. 550g	Approx. 610g

PFHd: Probability of dangerous failure per hour, MTTFd: Mean time to dangerous failure

Common specifications

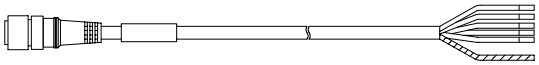
Item \ Type	Cable type	Pigtailed type
Model No.	**SF4C-H□**	**SF4C-H□-J05**
Sensing range	0.1 to 3m	
Beam pitch	20mm	
Detecting capability (Min. sensing object)	ø25mm opaque object	
Effective aperture angle (EAA)	±2.5 degree or less [for sensing range at 3m (Required by IEC 61496-2 / UL 61496-2)]	
Supply voltage	24V DC $^{+10}_{-15}$% Ripple P-P 10% or less	
Control output (OSSD 1 / 2)	PNP open-collector transistor / NPN open-collector transistor (switching type) **<For PNP output>** • Maximum source current: 200mA • Applied voltage: same as supply voltage (between the control output and +V) • Residual voltage: 2.5V or less (source current 200mA, when using 10m length cable) • Leakage current: 200µA or less (power supply OFF condition) • Maximum load capacity: 1µF (No load to maximum output current) • Load wiring resistance: 3Ω or less	**<For NPN output>** • Maximum sink current: 200mA • Applied voltage: same as supply voltage (between the control output and 0V) • Residual voltage: 2.5V or less (sink current 200mA, when using 10m length cable) • Leakage current: 200µA or less (power supply OFF condition) • Maximum load capacity: 1µF (No load to maximum output current) • Load wiring resistance: 3Ω or less
Operation mode (Output operation)	ON when all beams are received, OFF when one or more beams are interrupted (Note 1) (OFF when fault occurs in the sensor or the synchronization signal error, too)	
Protection circuit (Short-circuit protection)	Incorporated	
Response time	OFF: 7ms or less, ON: 90ms or less	
Auxiliary output (Non-safety output)	PNP open-collector transistor / NPN open-collector transistor (switching type) **<For PNP output>** • Maximum source current: 100mA • Applied voltage: same as supply voltage (between the auxiliary output and +V) • Residual voltage: 2.5V or less (source current 100mA, when using 10m length cable)	**<For NPN output>** • Maximum sink current: 100mA • Applied voltage: same as supply voltage (between the auxiliary output and 0V) • Residual voltage: 2.5V or less (sink current 100mA, when using 10m length cable)
Operation mode (Output operation)	When OSSDs are ON: OFF, when OSSDs are OFF: ON.	
Protection circuit (Short-circuit protection)	Incorporated	
Protection	IP65, IP67 (IEC)	
Ambient temperature	−10 to +55°C (No dew condensation or icing allowed), Storage: -25 to +60°C	
Ambient humidity	30 to 85% RH, Storage: 30 to 85% RH	
Ambient illuminance	Incandescent lamp: 5,000ℓx or less at the light-receiving surface	
Voltage withstandability	1,000V AC for one min. (between all supply terminals connected together and enclosure)	
Insulation resistance	20MΩ or more with 500V DC mega (between all supply terminals connected together and enclosure)	
Vibration resistance	10 to 55Hz frequency, 0.75mm amplitude in X, Y and Z directions for two hours each	
Shock resistance	300m/s^2 acceleration (approx. 30G) in X, Y and Z directions for three times each	
Emitting element	Infrared LED (Peak emission wavelength: 855nm)	
Connection method	Connection with connectors (intermediate connector type)	
Cable	0.15mm^2 12-core heat-resistant PVC cable, 5m long	0.15mm^2 12-core heat-resistant PVC cable with connector, 0.5m long
Cable extension	Extension up to total 40m is possible for both emitter and receiver, 0.2mm^2 or more, cable (Note 2)	
Material	Enclosure: Polycarbonate alloy, Sensing surface cover: Polycarbonate alloy, **MS-SFC-1** (Standard mounting bracket): Stainles steel	
Accessory	**MS-SFC-1** (Standard mounting bracket): 1 set, **SFC-TR25** (test rod): 1 set	
Applicable standard	EN 61496-1 (Type 4), EN 55011, IEC 61496-1/2 (Type 4) , ISO 13849-1: 2006 (Category 4, PLe), IEC 61508-1 to 7 (SIL3), JIS B 9704-1/2 (Type 4), JIS B 9705-1 (Category 4), JIS C 0508 (SIL3), UL 61496-1/2 (Type 4), UL1998 (Type 2)	

Notes: 1) The beam channel is not turned OFF during muting even if it is blocked.
2) When using a muting lamp, extend the cable so that the total cable length is 30.5m or less (for each emitter / receiver).

⚠ CAUTION Both emitter and receiver are adjusted before shipment, please apply both emitter and receiver with the same serial No. The serial No. is indicated on the plates of both emitter and receiver. (Under the model represents the serial No.)

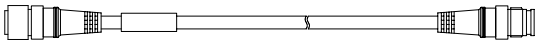
6-2 Options

- 12-core extending cable with connector on one end: 2 pcs. /set



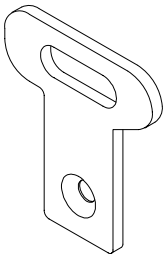
Model No.	Cable length	Remarks
SFB-CC3-MU	3m	Used for wiring. The connector is attached on one end of the cable and the other end is discrete wire. For emitter: Gray connector, 12-core shield cable For receiver: Black connector, 12-core shield cable
SFB-CC7-MU	7m	
SFB-CC10-MU	10m	

- 12-core extending cable with connectors on both ends: 1 pc.



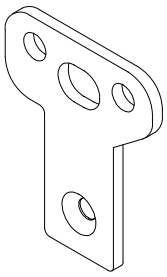
Model No.	Cable length	Remarks
SFB-CCJ10E-MU	10m	Used for extending cable. The connectors are attached on both ends of the cable. For emitter: Gray connector, 12-core shield cable For receiver: Black connector, 12-core shield cable
SFB-CCJ10D-MU		

- Standard mounting bracket: 4 pc./set



Model No	Remarks
MS-SFC-1	For one hexagon-socket head bolt [M5]

- **NA2-N** compatible mounting bracket: 4 pc./set

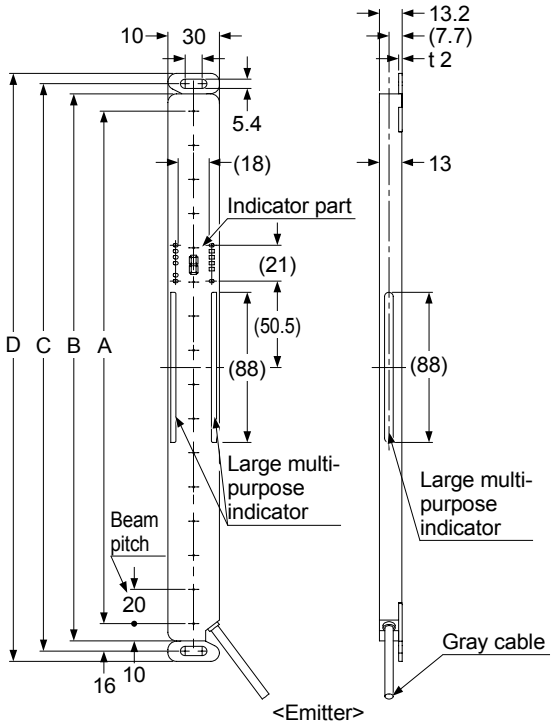


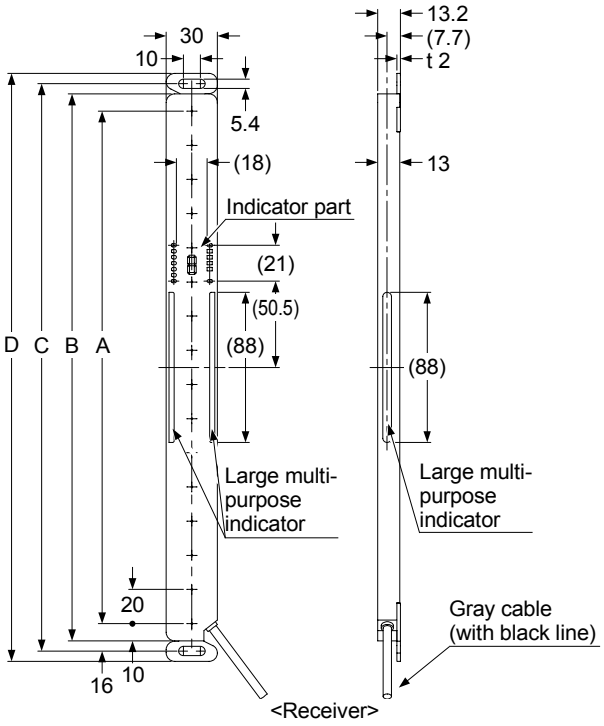
Model No	Remarks
MS-SFC-2	This mounting bracket is for replacing the other SUNX area sensor. With two M4 screws and one hexagon-socket head bolt [M6].

6-3 Dimension

6-3-1 In Case Mounting on the Center with Standard Mounting Brackets

(Unit: mm)

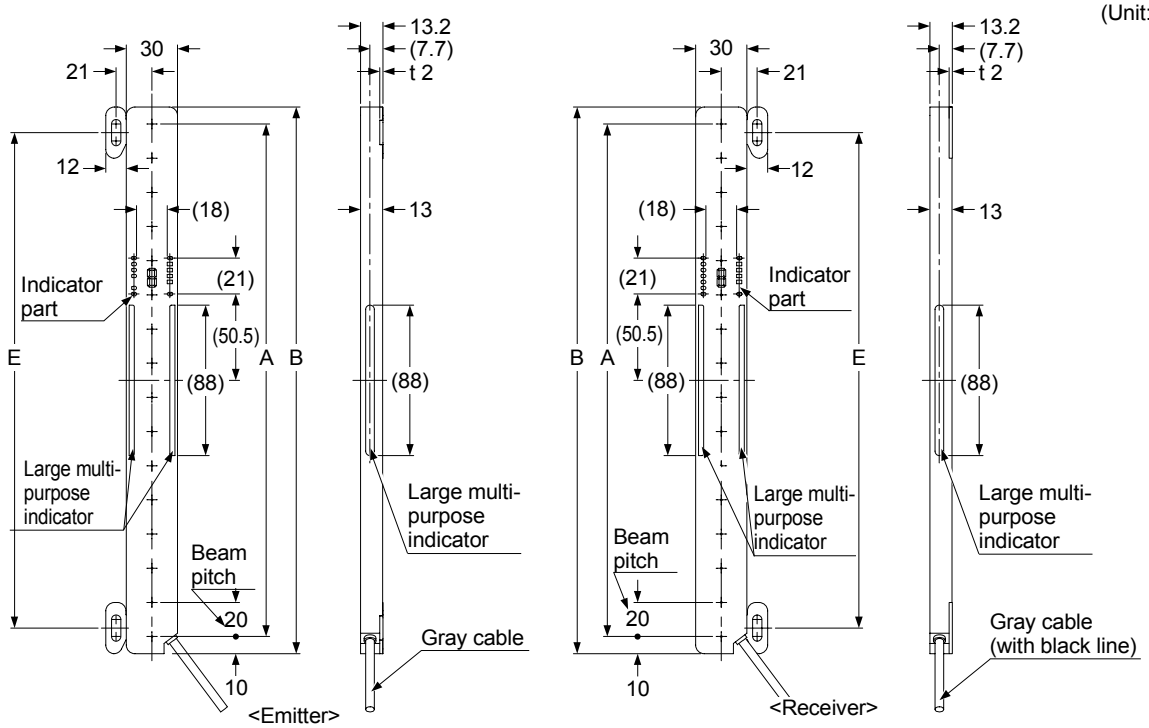




Model No.		A	B	C	D
SF4C-H8	**SF4C-H8-J05**	140	160	172	184
SF4C-H12	**SF4C-H12-J05**	220	240	252	264
SF4C-H16	**SF4C-H16-J05**	300	320	332	344
SF4C-H20	**SF4C-H20-J05**	380	400	412	424
SF4C-H24	**SF4C-H24-J05**	460	480	492	504
SF4C-H28	**SF4C-H28-J05**	540	560	572	584
SF4C-H32	**SF4C-H32-J05**	620	640	652	664

6-3-2 In Case Mounting with Standard Mounting Brackets without Dead Space

(Unit: mm)

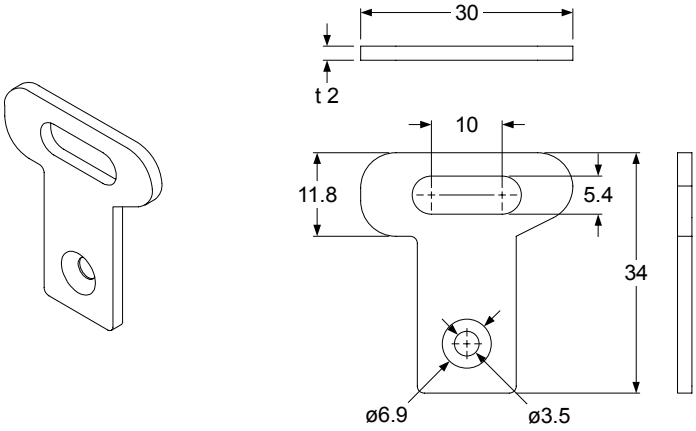


Model No.		A	B	E
SF4C-H8	**SF4C-H8-J05**	140	160	130
SF4C-H12	**SF4C-H12-J05**	220	240	210
SF4C-H16	**SF4C-H16-J05**	300	320	290
SF4C-H20	**SF4C-H20-J05**	380	400	370
SF4C-H24	**SF4C-H24-J05**	460	480	450
SF4C-H28	**SF4C-H28-J05**	540	560	530
SF4C-H32	**SF4C-H32-J05**	620	640	610

6-3-3 Mounting Bracket

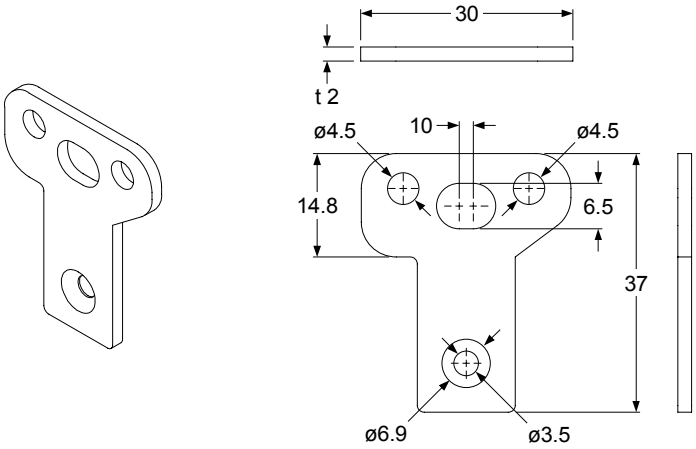
(Unit: mm)

1) Standerd mounting bracket / MS-SFC-1



Material: SUS304

2) NA2-N compatible mounting bracket / MS-SFC-2



Material: SUS304

Chapter 7 Others

7-1 Glossary

Machinery Directive	This directive is for an assembly of linked parts or components, energized by an electricity, compressed air or oil pressure, etc. and at least one of which moves, and a component which fulfills a safety function and is released into the market by itself.
EMC Directive	The directives is to any electric or electronic devices which will create more than a limited amount of RF interference, or will withstand a certain amount of Electro Magnetic fields while operating as intended within specifications.
EN 61496-1 IEC 61496-1/2 UL 61496-1/2 JIS B 9704-1/2	The standards that pertain to machine safety, especially electro-sensitive protective equipment (ESPE). EN 61496-1, IEC 61496-1, UL 61496-1 or JIS B 9704-1 gives general rules or failure mode and effect analysis, EMC requirements, etc. IEC 61496-2, UL 61496-2 or JIS B 9704-2 specifies effective aperture angle, protection against extraneous light sources, etc, for Active Opto-electronic Protective Devices (AOPDs).
IEC 61508-1 to 7 JIS C 0508-1 to 7	The standards that pertain to electrical / electronic / programmable electronic safety-related systems. They give roles for methods of reducing RISK to be acceptable and safety integrity level (SIL).
EN 55011	Specifies the limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.
ISO 13849-1 JIS B 9705-1	The standard that specifies the safety-related matters of machine safety / control system. They give roles for level (category) of structure and fault detection reliability, and for level of safety future performance capability (PL: Performance Level).
UL1998	UL standard for safety-related software in programmable components.
ESPE	The abbreviation for Electro-Sensitive Protective Equipment.
Control output (OSSD)	The abbreviation for Output Signal Switching Device. A component of the light curtain that turns OFF when light of the light curtain is blocked.
FSD	The abbreviation for Final Switching Device. The component of the machine's safety related control system that open-circuits the MPCE circuit when the OSSD operates due to the light from the light curtain being blocked.
Test rod	This is a rod for checking the detection capability of this device. It has dimensions corresponding to the minimum sensing object for this device.
Lockout	It is one of the safe status of this device. Operation is stopped if the self-diagnosis function determines that an irrecoverable failure (OSSDs do not operate normally, etc.) has occurred. If an emitter is in lockout condition, it will stop emitting light. If a receiver is in lockout condition, OSSDs are turned OFF.
Safety distance	It is the minimum distance that must be maintained between the light curtain and the dangerous parts of a machine so that the machine can be stopped before a human body or an object can reach the dangerous parts.
Sensing height (Protective height)	The length of the beam-axis direction that the min. sensing object can be detected. The length from the center of the first beam channel to the center of the last beam channel in addition to +20mm (10mm upward, 10mm downward).
Sensing range	It is the range between the facing emitter and receiver.
Sensing area	It is the area over which intrusion by people or objects can be detected by one set of the device. It is given by multiplying the protective height (sensing height) by the sensing range.
Test input function	This function enables checking of the device operation by forcibly turning ON / OFF the control output (OSSD 1 / 2) of the receiver with the emitting light is received.
PSDI	The abbreviation for the Presence Sensing Device Initiation. The safety device that restarts automatically without any operation by the operator after the device detects danger status and halts for a while.

Revision History

First edition: April 8, 2009
Second edition: April 22, 2009

(MEMO)

1. WARRANTIES:

(1) Subject to the exclusions stated in 2 (EXCLUSIONS) herein below, SUNX warrants the Products to be free of defects in material and workmanship for a period of one (1) year from the date of shipment under normal usage in environments commonly found in manufacturing industry.

(2) Any Products found to be defective must be shipped to SUNX with all shipping costs paid by Purchaser or offered to SUNX for inspection and examination. Upon examination by SUNX, SUNX will, at its sole discretion, repair or replace at no charge, or refund the purchase price of, any Products found to be defective.

2. EXCLUSIONS:

(1) This warranty does not apply to defects resulting from any cause:
- (i) which was due to abuse, misuse, mishandling, improper installation, improper interfacing, or improper repair by Purchaser;
- (ii) which was due to unauthorized modification by Purchaser, in part or in whole, whether in structure, performance or specification;
- (iii) which was not discoverable by a person with the state-of-the-art scientific and technical knowledge at the time of manufacture;
- (iv) which was due to an operation or use by Purchaser outside of the limits of operation or environment specified by SUNX;
- (v) which was due to normal wear and tear;
- (vi) which was due to Force Majeure; and
- (vii) which was due to any use or application expressly discouraged by SUNX in 4 (CAUTIONS FOR SAFE USE) hereunder.

(2) This warranty extends only to the first purchaser for application, and is not transferable to any person or entity which purchased from such purchaser for application.

3. DISCLAIMERS

(1) SUNX's sole obligation and liability under this warranty is limited to the repair or replacement, or refund of the purchase price, of a defective Product, at SUNX's option.

(2) THE REPAIR, REPLACEMENT, OR REFUND IS THE EXCLUSIVE REMEDY OF THE PURCHASER, AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF PROPRIETARY RIGHTS, ARE HEREBY EXPRESSLY DISCLAIMED. IN NO EVENT SHALL SUNX AND ITS AFFILIATED ENTITIES BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCTS, OR FOR ANY INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND, GENERAL TERMS AND CONDITIONS 4 OR ANY DAMAGES RESULTING FROM LOSS OF USE, BUSINESS INTERRUPTION, LOSS OF INFORMATION, LOSS OR INACCURACY OF DATA, LOSS OF PROFITS, LOSS OF SAVINGS, THE COST OF PROCUREMENT OF SUBSTITUTED GOODS, SERVICES OR TECHNOLOGIES, OR FOR ANY MATTER ARISING OUT OF OR IN CONNECTION WITH THE USE OR INABILITY TO USE THE PRODUCTS.

4. CAUTIONS FOR SAFE USE

(1) The applications shown in the catalogue are only suggestions, and it is Purchaser's sole responsibility to ascertain the fitness and suitability of the Products for any particular application, as well as to abide by Purchaser's applicable local laws and regulations, if any.

(2) Never use the Products NOT rated or designated as “SAFETY SENSOR” in any application involving risk to life or property. When such a use is made by Purchaser, such Purchaser shall indemnify and hold harmless SUNX from any liability or damage whatsoever arising out of or in relation to such use.

(3) In incorporating the Products to any equipment, facilities or systems, it is highly recommended to employ fail-safe designs, including but not limited to a redundant +++design, flame propagation prevention design, and malfunction prevention design so as not to cause any risk of bodily injury, fire accident, or social damage due to any failure of such equipment, facilities or systems.

(4) The Products are each intended for use only in environments commonly found in manufacturing industry, and, unless expressly allowed in the catalogue, specification or otherwise, shall not be used in, or incorporated into, any equipment, facilities or systems, such as those:
- (a) which are used for the protection of human life or body parts;
- (b) which are used outdoors or in environments subject to any likelihood of chemical contamination or electromagnetic influence;
- (c) which are likely to be used beyond the limits of operations or environments specified by SUNX in the catalogue or otherwise;
- (d) which may cause risk to life or property, such as nuclear energy control equipment, transportation equipment (whether on rail or land, or in air or at sea), and medical equipment;
- (e) which are operated continuously each day for 24 hours; and
- (f) which otherwise require a high level of safety performance similar to that required in those equipment, facilities or systems as listed in (a) through (e) above.

5. EXPORT CONTROL LAWS

In some jurisdictions, the Products may be subject to local export laws and regulations. If any diversion or re-export is to be made, Purchaser is advised to abide by such local export laws and regulations, if any, at its own responsibility.

SUNX Limited URL : sunx.com

Overseas Sales Division (Head Office)
2431-1 Ushiyama-cho, Kasugai-shi, Aichi, 486-0901, Japan
Phone: +81-568-33-7861 FAX: +81-568-33-8591

Europe Headquarter: Panasonic Electric Works Europe AG
Rudolf-Diesel-Ring 2, D-83607 Holzkirchen, Germany
Phone: +49-8024-648-0

US Headquarter: Panasonic Electric Works Corporation of America
629 Central Avenue New Providence, New Jersey 07974 USA
Phone: +1-908-464-3550

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